

Project Manual

for

PSJA ISD New Swimming Facilities

PBK Project No.: 18309SP

for the

**PHARR-SAN JUAN-ALAMO INDEPENDENT SCHOOL
DISTRICT**

11 April 2019

Issued for Proposal



Project Manual

for

PSJA ISD New Swimming Facilities

PBK Project No.: 18309SP

for the

PHARR-SAN JUAN-ALAMO INDEPENDENT SCHOOL DISTRICT

11 April 2019

Issued for Proposal

Board of Trustees

Mr. Jesus "Jesse" Zambrano
Mr. Jorge "George" Palacios
Mr. Jorge Zambrano
Mr. Ricardo "Rick" Pedraza
Mr. Jesys "Jesse" Vela, Jr.
Mr. Carlos G. Villegas, Jr.

President
Vice President
Secretary- Treasure
Assistant Secretary- Treasure
Trustee
Trustee
Trustee

Administration

Mr. Daniel P. King, PhD

Superintendent



Project Manual

for

PSJA ISD New Swimming Facilities

PBK Project No.: 18309SP

for the

PHARR-SAN JUAN-ALAMO INDEPENDENT SCHOOL DISTRICT

11 April 2019

Issued for Proposal

Consultants

Architect

PBK
11 Greenway Plaza Blvd, 22nd Floor
Houston, Texas 77046
Phone: (713) 965-0608

Sports

PBK Sports
11 Greenway Plaza Blvd, 15th Floor
Houston, Texas 77046
Phone: (713) 965-0608

Structural

Chanin Engineers
400 Nolana Ave, Ste. H2
McAllen, Texas 78504
Phone: (956) 687 - 9421

MEP

LEAF
601 N.W Loop 410, Ste. 400
San Antonio, Texas 78216
Phone: (210) 638-7200

Technology

LEAF
601 N.W Loop 410, Ste. 400
San Antonio, Texas 78216
Phone: (210) 638-7200

Landscape

Heffner Design Team
4814 N. 11th Street, Suite E
McAllen, Texas 78504
(956) 540- 7850

Civil

Melden & Hunt, Inc.
115 W. McIntyre
Edinburg, Texas 78541
Phone: (956) 381-1839

Aquatics

Counsleman- Hunsaker
10733 Sunset Office Dr. Ste. 400
St. Louis, MO 63127
Phone: (314) 894 - 1245

Geotechnical





Terracon Consultants, Inc.
1506 Mid-Cities Dr.
Pharr, Texas 78577
Phone: (956) 283 - 8254




Facilities

Beam Professionals
11 Greenway Plaza Blvd, 15th Floor
Houston, Texas 77046
Phone: (713) 965-0608

Issue for Proposal

Each specification section included herein is listed in the Project Manual Table of Contents with a letter code, indicated below, designating the Designer of Record responsible for its preparation, under whose seal and/or authority it is issued for the purpose(s) stated above. Seals and signatures do not apply to documents not included herein, nor (except as otherwise indicated) to documents prepared by the Owner or others ("O"), including but not necessarily limited to documents in Division 00, geotechnical and other reports, etc.

| | | |
|--|---|--|
| <p>Architect of Record:</p> <p>(Name)</p> <p>R.A. #</p> |  <p>04/11/19</p> | |
| <p>Architect of Record, Landscape:</p> <p>Andrew Heffner</p> <p>R.A. # 2528</p> |  <p>04/11/19</p> | |
| <p>Licensed Irrigator:</p> <p>Robert Duran</p> <p>L.R. # 16516</p> |  <p>04/11/19</p> | |
| <p>Engineer of Record, Structural:</p> <p>Miguel Chanin</p> <p>P.E. # 93124</p> |  <p>04-11-19</p> | |

| | | |
|--|---|--|
| Engineer of Record, Mechanical, Electrical, & Plumbing: Donald C. Richards P.E. # 61525 |  | |
| Engineer of Record, Civil: Mario A. Reyna P.E. # 117368 |  04/11/19 | |
| Engineer of Record, Aquatics: Darren Bevard P.E # 104309 |  4.11.19 | |

DOCUMENT 00 00 10 TABLE OF CONTENTS

| <i>Section No.</i> | <i>Title</i> |
|--------------------|---|
| 00 00 01 | Professional Seals Page |
| 00 00 10 | Table of Contents |
| | Geotechnical Report – Early College High School |
| | -Boring Logs |
| | Geotechnical Report – Memorial Early College High School |
| | -Boring Logs |
| 00 11 00 | Request For Competitive Sealed Proposal Form |
| 00 40 00 | Proposal Bond |
| 00 40 11 | Felony Conviction Notification |
| 00 40 12 | List of Subcontractors |
| 00 40 17 | Certification of Criminal History |
| 00 40 18 | Conflict of Interest Questionnaire |
| 00 45 00 | Non-Discriminatory Employment |
| 00 50 00 | Texas Statutory Performance Bond |
| 00 63 00 | Civil Engineering Request for Information |
| 00 65 02 | Waiver and Release of Liens |
| 00 72 00 | AIA Document 101 – Standard Form of Agreement between Owner and Contractor |
| 00 73 00 | General Conditions of the Contract for Construction Supplementary Conditions |

DIVISION 1 GENERAL REQUIREMENTS

| | |
|----------|-------------------------------------|
| 01 11 00 | Summary |
| 01 21 00 | Allowances |
| 01 23 00 | Alternates |
| 01 25 13 | Substitution Procedures |
| 01 26 00 | Contract Modification Procedures |
| 01 29 00 | Payment Procedures |
| 01 29 73 | Schedule of Values |
| 01 31 00 | Project Management and Coordination |
| 01 32 00 | Construction Progress Documentation |
| 01 32 33 | Photographic Documentation |
| 01 33 00 | Submittal Procedures |
| 01 40 00 | Quality Requirements |
| 01 42 00 | References |
| 01 45 23 | Testing and Inspection Services |
| 01 50 00 | Temporary Facilities and Controls |
| 01 60 00 | Product Requirements |
| 01 73 00 | Execution Requirements |
| 01 73 29 | Cutting and Patching |
| 01 77 00 | Closeout Procedures |
| | Close out Forms |
| 01 78 39 | Project Record Documents |
| 01 79 00 | Demonstration and Training |

DIVISION 2 EXISTING CONDITIONS- NOT USED

DIVISION 3 CONCRETE

| | |
|----------|--------------------------------|
| 03 10 00 | Concrete Forms and Accessories |
| 03 15 00 | Concrete Accessories |
| 03 20 00 | Concrete Reinforcement |
| 03 30 00 | Cast In Place Concrete |

| | |
|----------|--------------------|
| 03 35 00 | Concrete Finishing |
| 03 36 00 | Concrete Finishes |
| 03 39 00 | Concrete Curing |
| 03 60 00 | Grout |

DIVISION 4 MASONRY

| | |
|----------|------------------------------------|
| 04 05 14 | Masonry Mortar and Grout |
| 04 20 16 | Reinforced Unit Masonry Assemblies |
| 04 22 00 | Concrete Unit Masonry |

DIVISION 5 METALS

| | |
|----------|-------------------------------|
| 05 12 00 | Structural Steel |
| 05 21 00 | Steel Joists |
| 05 31 23 | Steel Roof Deck |
| 05 50 00 | Metal Fabrications |
| 05 51 19 | Slip Resistant Metal Gratings |
| 05 52 00 | Metal Railings |

DIVISION 6 WOOD, PLASTICS, AND COMPOSITES

| | |
|----------|----------------------------|
| 06 20 00 | Finish Carpet and Millwork |
|----------|----------------------------|

DIVISION 7 THERMAL AND MOISTURE PROTECTION

| | |
|----------|---|
| 07 13 00 | Shower Stall Waterproofing |
| 07 19 00 | Water Repellents |
| 07 21 00 | Thermal Insulation |
| 07 27 26 | Fluid Applied Air Barrier System |
| 07 41 13 | Prefinished Metal Roofing |
| 07 42 13 | Formed Metal Wall Panels |
| 07 42 16 | Metal Composite Material Walls |
| 07 54 19 | Fully Adhered Thermoplastic Hybrid Membrane Roofing |
| 07 62 00 | Rood Related Sheet Metal |
| 07 65 00 | Flexible Flashing |
| 07 72 00 | Roof Accessories |
| 07 72 33 | Roof Scuttle (Hatches) |
| 07 92 00 | Joint Sealants |

DIVISION 8 OPENINGS

| | |
|----------|-------------------------------|
| 08 16 00 | Fiberglass Doors and Frames |
| 08 31 13 | Access Doors and Frames |
| 08 44 13 | Glazed Aluminum Curtain Walls |
| 08 71 00 | Door Hardware |
| 08 80 00 | Glazing |
| 08 83 00 | Mirrors |
| 08 87 13 | Security Window Film |
| 08 91 00 | Fixed Louvers |

DIVISION 9 FINISHES

| | |
|----------|-----------------------------|
| 09 21 16 | Gypsum Board Assemblies |
| 09 30 19 | Porcelain Tile |
| 09 51 00 | Acoustical Ceiling Panels |
| 09 65 13 | Resilient Base |
| 09 65 23 | Luxury Vinyl Tile Flooring |
| 09 65 66 | Resilient Athletic Flooring |
| 09 67 00 | Epoxy Flooring |
| 09 90 00 | Painting and Coatings |

DIVISION 10 SPECIALTIES

| | |
|----------|---------------------------|
| 10 01 00 | Miscellaneous Specialties |
| 10 11 00 | Markerboard and Tackboard |

| | |
|----------|-----------------------------------|
| 10 14 00 | Graphics |
| 10 21 13 | Solid Plastic Toilet Compartments |
| 10 28 13 | Toilet Accessories |
| 10 44 00 | Fire Extinguishers and Cabinets |
| 10 51 26 | Solid Plastic Toilet Compartments |
| 10 56 13 | Plastic Storage Shelving |
| 10 73 13 | Aluminum Canopy |
| 10 73 26 | Walkway Coverings |

DIVISION 11 EQUIPMENT

| | |
|----------|------------------------|
| 11 31 00 | Residential Appliances |
|----------|------------------------|

DIVISION 12 FURNISHINGS

| | |
|----------|---------------|
| 12 24 00 | Window Shades |
|----------|---------------|

DIVISION 13 Special Construction

| | |
|----------|---|
| 13 11 00 | Swimming Pools |
| 13 11 01 | Swimming Pool Cast – In- Place Concrete |
| 13 11 02 | Swimming Pool Shotcrete |
| 13 11 03 | Swimming Pool Cementitious Finish |
| 13 11 04 | Swimming Pool Tile |
| 13 11 06 | Swimming Pool Timing System |
| 13 34 19 | Metal Building Systems |

DIVISION 22 PLUMBING

| | |
|----------|--|
| 22 05 00 | Common Work Results for Plumbing |
| 22 05 16 | Expansion Fittings and Loops for Plumbing Piping |
| 22 05 29 | Plumbing Hangers and Supports |
| 22 11 16 | Domestic Water Piping |
| 22 13 16 | Sanitary Waste and Vent Piping |
| 22 14 13 | Storm Drainage Piping |
| 22 20 23 | Gas Piping |
| 22 30 00 | Plumbing Equipment |
| 22 40 00 | Plumbing Fixtures |

DIVISION 23 HEATING, VENTILATING & A.C.

| | |
|----------|--|
| 23 05 00 | Common Work Results for HVAC |
| 23 05 13 | Common Motor Requirements for HVAC Equipment |
| 23 05 14 | Variable Frequency Drives |
| 23 05 29 | Hangers and Supports for HVAC Piping and Equipment |
| 23 05 48 | Vibration and Seismic Controls for HVAC Piping and Equipment |
| 23 05 53 | Identification for HVAC Piping and Equipment |
| 23 05 93 | Testing, Adjusting, and Balancing for HVAC |
| 23 07 13 | Duct Insulation |
| 23 08 00 | Commissioning of HVAC Systems |
| 23 09 93 | Sequences of Operation for HVAC Controls |
| 23 22 00 | Condensate Piping |
| 23 31 13 | Metal Ducts |
| 23 33 00 | Air Duct Accessories |
| 23 34 00 | HVAC Fans |
| 23 37 13 | Diffusers, Registers, and Grilles |
| 23 37 23 | HVAC Gravity Ventilators |

- 23 74 13.19 Packaged, Outdoor, Central- Station Air- Handling Units with
Energy Recovery Wheels
- 23 81 26 Ductless Mini- Split-System Air- Conditioners
- 23 82 39.19 Electric Unit Heaters

DIVISION 26 ELECTRICAL

- 26 01 05 Commissioning of Electrical Systems By Cx Professional
- 26 01 06 Preparation for Commissioning of Electrical Systems by Contractor
- 26 05 00 Common Work Results for Electrical
- 26 05 19 Low Voltage Electrical Power Conductors and Cables
- 26 05 26 Grounding and Bonding for Electrical Systems
- 26 05 29 Hangers and Supports for Electrical Systems
- 26 05 33 Raceway and Boxes for Electrical Systems
- 26 05 53 Identification for Electrical Systems
- 26 09 23 Digital Lighting Control System
- 26 20 00 Enclosed Switches, Enclosed Circuit Breakers and Motor Controllers
- 26 22 00 Low Voltage Transformers
- 26 24 16 Electrical Panelboards
- 26 27 26 Wiring Devices
- 26 33 23 Central Battery/Inverter System
- 26 41 00 Lighting Protection Systems
- 26 43 00 Surge Protective Devices (SPDs) for Low Voltage Power
- 26 50 00 Interior Lighting
- 26 56 00 Exterior Lighting

DIVISION 27 TECHNOLOGY & AUDIO VISUAL

- 27 10 00 Structured Cabling System
- 27 51 00 Integrated Telecommunications

DIVISION 28 SAFETY & SECURITY

- 28 13 00 Access Control System
- 28 16 00 Intrusion Detection System
- 28 23 00 IP Surveillance Camera System
- 28 31 00 Analog Fire Alarm System

DIVISION 31 EARTHWORK

- 31 05 13 Soils for Earthwork
- 31 06 00 Excavation, Backfilling and Compacting for Structure
- 31 10 00 Site Clearing
- 31 14 00 Earthwork
- 31 20 00 Aggregate Materials
- 31 22 00 Excavation, Backfilling and Compaction for Pavement
- 31 22 13 Rough Grading
- 31 23 00 Excavation, Backfilling and Compacting for Utilities
- 31 23 16 Excavation and Fill
- 31 31 16 Termite Control
- 31 32 00 Soil Stabilization
- 31 35 00 Slope Protection and Erosion Control
- 31 63 29 Drilled Concrete Piers

DIVISION 32 EXTERIOR IMPROVEMENTS

- 32 11 00 Paving Base Course
- 32 12 00 Asphaltic Concrete Paving
- 32 13 00 Portland Cement Concrete Paving
- 32 13 13 Concrete Paving
- 32 16 00 Curb and Sidewalks

| | |
|----------|--|
| 32 17 23 | Pavement Markings |
| 32 31 14 | PVC Coated Chain Link Fences and Gates |
| 32 84 00 | Irrigation |
| 32 84 01 | Non- Potable Irrigation |
| 32 92 00 | Turfgrass |
| 32 93 00 | Plants |

DIVISION 33 UTILITIES

| | |
|----------|----------------------------|
| 33 11 00 | Water Distribution Systems |
| 33 21 00 | Site Gas Lines |
| 33 31 00 | Sanitary Sewer System |
| 33 39 00 | Sewer Structures |
| 33 41 00 | Storm Sewer Systems |

END OF DOCUMENT 00 01 00



Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool
San Juan, Texas

January 3, 2019

Terracon Project No. 88185143

Prepared for:

Pharr-San Juan-Alamo ISD
San Juan, Texas

Prepared by:

Terracon Consultants, Inc.
Pharr, Texas



January 3, 2019

Pharr-San Juan-Alamo ISD
601 East Kelly Street
San Juan, Texas 78577



Attn: Mr. Jerry Lopez
P: (956) 684 6384
E: gerardo.lopez@psjaisd.us

Re: Geotechnical Engineering Report
PSJA Early College HS - Outdoor Pool
805 W. Ridge Road
San Juan, Texas
Terracon Project No. 88185143

Dear Mr. Lopez:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P88185143 dated November 15, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork, design and construction of foundations and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.
(Texas Firm Registration No.: F-3272)


Martin Reyes
Senior Staff Engineer




Alfonso A. Soto, P.E., D.GE.
Principal

REPORT TOPICS

| | |
|------------------------------------|----|
| INTRODUCTION..... | 1 |
| SITE CONDITIONS..... | 1 |
| PROJECT DESCRIPTION..... | 2 |
| GEOTECHNICAL CHARACTERIZATION..... | 3 |
| GEOTECHNICAL OVERVIEW | 3 |
| EARTHWORK..... | 4 |
| SHALLOW FOUNDATIONS..... | 8 |
| MAT FOUNDATION..... | 13 |
| DEEP FOUNDATIONS | 14 |
| SWIMMING POOLS..... | 19 |
| SEISMIC CONSIDERATIONS | 20 |
| FLOOR SLABS..... | 20 |
| LATERAL EARTH PRESSURES | 22 |
| PAVEMENTS..... | 24 |
| FROST CONSIDERATIONS..... | 30 |
| SULFATE CONSIDERATIONS | 31 |
| GENERAL COMMENTS..... | 31 |
| FIGURES | 33 |

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the [GeoReport](#) logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

| Topic ¹ | Overview Statement ² |
|--------------------------------------|---|
| Project Description | Single-story building and outdoor pool complex. |
| Geotechnical Characterization | <ul style="list-style-type: none"> ■ Groundwater was not observed either during or upon completion of drilling operations. ■ The subsurface soils at this site generally consist of Sandy Lean Clay (CL) and Sandy Silt (ML). |
| Potential Vertical Rise (PVR) | The existing Potential Vertical Rise (PVR) of the soils within the proposed building and swimming pool areas in present condition is less than 1 inch. |
| Seismic Site Classification | The subsurface conditions within the site are consistent with the characteristics of Site Class D as defined in the International Building Code (IBC) Site Classification. |
| Foundations | A shallow and/or deep foundation system would be appropriate to support the structural loads of the proposed structures, provided the pads are prepared as recommended in this report. |
| Below-Grade Structures | Pool walls may be designed as either cantilevered or restrained retaining walls. |
| Earthwork | The subgrade should be prepared as noted in Earthwork . |
| Pavements | <p>Flexible and rigid pavement systems may be considered for this project. We anticipate traffic may consist primarily of small vehicles, midsize trucks and occasional garbage trucks.</p> <p>The subgrade should be prepared as noted in Earthwork, flexible pavement sections vary from 2 to 3 inches of Hot Mix Asphaltic Concrete (HMAC) over 6 to 10 inches of granular base material with treated subgrade or moisture conditioned subgrade. The rigid pavement system varies from 5 to 7 inches of reinforced concrete with moisture conditioned subgrade.</p> |
| General Comments | This section contains important information about the limitations of this geotechnical engineering report. |

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report
PSJA Early College HS - Outdoor Pool
805 W. Ridge Road
San Juan, Texas
Terracon Project No. 88185143
January 3, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed PSJA Early College HS - Outdoor Pool to be located at 805 W. Ridge Road in San Juan, Texas. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Swimming pool
- Excavation considerations
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Lateral earth pressures
- Pavement design and construction
- Frost considerations

The geotechnical engineering Scope of Services for this project included the advancement of 8 test borings to depths ranging from approximately 6 to 20 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic maps.

| Item | Description |
|--------------------|---|
| Parcel Information | The project is located at 805 W. Ridge Road in San Juan, Texas. Approx. GPS coordinates: Latitude: 26.17715° N Longitude: -98.165792° W. See Site Location |

Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

January 3, 2019 ■ Terracon Project No. 88185143



| Item | Description |
|-----------------------|---|
| Existing Improvements | Undeveloped land. |
| Current Ground Cover | Earthen and lightly vegetated. |
| Existing Topography | Relatively flat and level. |
| Geology | The Geologic Atlas of Texas (1976), McAllen - Brownsville sheet has mapped the In-Rio Grande Delta, clay veneer over meander belt sand Formation (Qbv) of the Quaternary age at or near this site. The soils are mostly composed of clay and sand, floodplain deposits mud veneer over meander belt sands, little grain preserved (part of Beaumont Formation). |

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

| Item | Description |
|---------------------------------|---|
| Information Provided | By Mr. David Iglesias with PBK on November 14, 2018. |
| Project Description | Single-story building and outdoor pool complex. |
| Proposed Structures | The project will include the construction of a single-story building and a pool complex that consist of three (3) swimming pools: outdoor 25 yd x 25 m, instructional and diving pools. The pool water depths may vary from 3 feet for shallow water areas to 12.5 feet or greater for diving areas. Development may also include construction of flexible and/or rigid pavements for the main access lanes and parking area. |
| Building Construction | We anticipate that the building will likely consist of pre-engineered metal structure with CMU, brick veneer or stucco exterior walls supported by a shallow or deep foundation system. |
| Finished Floor Elevation (FFE) | Information was not provided at this time. |
| Maximum Loads (assumed) | <ul style="list-style-type: none">■ Columns: 30 kips■ Walls: 3 kips per linear foot■ Slabs: 250 pounds per square foot |
| Grading/Slopes | Up to 1 foot of cut and 2 feet of fill may be required to develop final grade. |
| Below-Grade Areas | Swimming pools. |
| Pavements | Flexible and rigid pavements may be considered for this project. |
| Estimated Start of Construction | Information was not provided at this time. |

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs and the GeoModel can be found in the **Exploration Results** and in the **Figures** sections of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

| Model Layer | Layer Name | General Description |
|-------------|-----------------|---|
| 1 | Sandy Lean Clay | Sandy Lean Clay (CL), soft to very stiff |
| 2 | Sandy Silt | Sandy Silt (ML), non-plastic, loose to medium dense |

The boreholes were drilled to their full depths using dry drilling techniques to aid in the observation of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration that the borings were allowed to remain open. The boreholes can be found on the boring logs in **Exploration Results**.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. The boreholes were backfilled with on-site soil cuttings after completion of the groundwater level observations.

GEOTECHNICAL OVERVIEW

Our findings indicate the proposed building structure can be supported on a shallow or deep foundation system. The desired foundation system may be used at this site provided the site and foundation are designed and constructed as recommended in this report.

The suitability and performance of a soil supported foundation for a structure depends on many factors including the magnitude of soil movement expected, the type of structure, the intended use of the structure, the construction methods available to stabilize the soils, and our understanding of the owner's expectations of the completed structure's performance.

Low to moderately expansive soils are present on this site. This report provides recommendations to help mitigate the effects of soil settlement, shrinkage and expansion. However, even if these procedures are followed, some movement in the structure should be anticipated. Eliminating the risk

of movement may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of data presented herein, engineering analyses, and our current understanding of the proposed project.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Construction areas should be stripped of all vegetation, topsoil and other unsuitable material. Additional excavation as recommended in this report or as needed should be performed within the proposed building and pool areas. Once final subgrade elevation has been achieved, the exposed subgrade should be carefully proofrolled with a 15-ton pneumatic roller or a fully loaded dump truck to detect weak zones in the subgrade. Special care should be exercised when proofrolling the fill soils to detect soft/weak areas. Weak areas detected during proofrolling, as well as zones of fill containing organic matter and/or debris should be removed and replaced with select fill in the proposed building and pool areas. Proper site drainage should be maintained during construction, so that ponding of surface runoff does not occur and cause construction delays and/or inhibit site access.

Subsequent to proofrolling, and just prior to placement of fill, the exposed subgrade within the construction area should be evaluated for moisture and density. If the moisture, density, and/or the requirements do not meet the criteria described in the table below, the subgrade should be scarified to a minimum depth of 8 inches, moisture adjusted and compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density. Select fill should meet the following criteria.

Fill Material Types

Engineered fill should consist of approved materials, free of organic material, debris and particles larger than about 2 inches. The maximum particle size criteria may be relaxed by the geotechnical engineer of record depending on construction techniques, material gradation, allowable lift thickness and observations during fill placement. Soils for use as engineered fill material should conform to the following specifications:

| Fill Type ¹ | USCS Classification | Acceptable Location for Placement |
|---|--|---|
| Aggregate Base Course ² | SC, GC, Caliche, Crushed Limestone, Crushed Concrete | Top 6 inches of building pad area. |
| Select Fill | CL and/or SC ($7 \leq PI \leq 20$) | Must be used to construct the building pad, pavements and all grade adjustments within the construction area. |
| On-Site Soils | CL | On-site soils CL may be suitable for use as fill within the building, pavement and landscaping areas. |

1. Prior to any filling operations, samples of the proposed borrow and on-site materials should be obtained for laboratory moisture-density testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to evaluate that proper levels of compaction, including dry unit weight and moisture content, are being attained.
2. Crushed limestone and crushed concrete material should meet the requirements of 2014 TxDOT Item 247, Type A, or D, Grades 1-2 and/or 3. The select fill materials should be free of organic material and debris and should not contain stones larger than 2 inches in the maximum dimension. The clayey gravel and caliche materials should meet the gradation requirements of Item 247, Type B, Grades 1-2 and/or 3 as specified in the 2014 TxDOT Standard Specifications Manual and a Plasticity Index between 7 and 20.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

| Item | Description |
|--|---|
| Fill Lift Thickness | The fill should be placed in loose lifts of about 8 inches, with compacted thickness not exceeding 6 inches. |
| Compaction Requirements (on-site soils, subgrade and select fill) | The on-site soils and select fill should be compacted to at least 95 percent of The Standard Effort (ASTM D698) maximum dry density within 2 percentage points of the optimum moisture content. |

Wet Weather/Soft Subgrade Considerations

Construction operations may encounter difficulties due to the wet or soft surface soils becoming a general hindrance to equipment due to rutting and pumping of the soil surface, especially during and soon after periods of wet weather.

If the subgrade cannot be adequately compacted to minimum densities as described above, one of the following measures will be required:

- Removal and replacement with select fill,
- Chemical treatment of the soil to dry and increase the stability of the subgrade, or
- Drying by natural means if the schedule allows.

In our experience with similar soils in this area, chemical treatment is the most efficient and effective method to increase the supporting value of wet and weak subgrade. Terracon should be contacted for additional recommendations if chemical treatment of the soils is needed.

Prior to placing any fill, all surface vegetation, topsoil, possible fill material and any otherwise unsuitable materials should be removed from the construction areas. Wet or dry material should either be removed, or moisture conditioned and recompacted. After stripping and grubbing, the subgrade should be proof-rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a 15-ton roller or fully loaded dump truck. Soft, dry and low-density soil should be removed or compacted in place prior to placing fill.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Planters and other surface features which could retain water in areas adjacent to the building(s) should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structures, we recommend that protective slopes be provided with a minimum grade of approximately 3 percent for at least 10 feet from perimeter walls, except in areas where ADA ramps are required, these areas should comply with state and local regulations. Backfill against exterior walls, and in utility and sprinkler line trenches, should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Downspouts, roof drains or scuppers should discharge into extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Consideration should be given to extending drainage piping to day light at the face of curbs then empty onto pavement surfaces. Sprinkler systems should not be installed within 5 feet of foundation walls. Landscaped irrigation adjacent to the foundation systems should be minimized or eliminated.

Where paving or flatwork abuts the structure(s), effectively seal and maintain joints to prevent surface water infiltration. The joint between the sidewalk curb and building(s) should be sealed. The sidewalk curb along the building line is recommended to prevent water from standing over the joint between the building and sidewalk should the outside edge of the slab rise due to soil swelling at the sidewalk edge.

Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the structures should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the structures.

We recommend constructing an effective clay “trench plug” that extends at least 5 feet out from the perimeter. The plug material should consist of clay compacted at a water content at or above the soils optimum water content. The clay fill should be placed to surround the utility line and be compacted in accordance with recommendations in this report.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompact prior to floor slab construction.

The groundwater table could affect overexcavation efforts, especially for over-excavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps could be necessary to achieve the recommended depth of over-excavation.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

Based upon the subsurface conditions observed during our investigation a shallow (slab-and-grade, strip/spread footings) foundation system would be appropriate to support the structural loads of the proposed structures provided the subgrade is prepared as discussed in this report. Recommendations for this type of foundation system is provided in the following sections, along with other geotechnical considerations for this project.

The slab-on-grade foundation may be designed using the following parameters provided the subgrade is prepared as outlined in the **Earthwork** and **Floor Slabs** sections of this report:

Slab-on-Grade Foundation - Design Parameters

| Item | Description |
|--|--|
| Select Fill Pad | Minimum 1½ feet of select fill over 12 inches of moisture conditioned and compacted on-site soils. |
| Allowable Bearing Pressure ¹ n Compacted Select Fill | Net Total Load - 2,000 psf |
| Climatic Rating | 15 |
| Design Plasticity Index | 20 |

| Item | Description |
|--|-------------------------------------|
| Soil Support Index | 0.95 |
| Estimated PVR ² | About 1 inch or less |
| Approximate Total Settlement ³ | About ½ inch |
| Estimated Differential Settlement ³ | Approximately ½ of total settlement |
| Min. Perimeter Grade Beam Embedment ⁴ | 18 inches below finished grade |

1. The net allowable bearing pressure provided above include a factor of safety of at least 2.
2. The slab-on-grade foundation system should be designed to tolerate the anticipated soil movement and provide satisfactory support to the proposed structures. The foundation should have adequate exterior and interior grade beams to provide sufficient rigidity to the foundation system such that the slab deflections that result are considered tolerable to the supported structures.
3. This estimated post-construction settlement is assuming proper construction practices are followed. Settlement response of a select fill supported slab is influenced more by the quality of construction than by soil-structure interaction. Therefore, it is essential that the recommendations for foundation construction be strictly followed during the construction phases of the pad and foundation.
4. To bear within the select fill or moisture conditioned and recompacted on-site soils. The grade beams may be thickened and widened where necessary to support column loads.

Construction Considerations for Slab-on-grade Foundation

Excavations for grade beams should be performed with equipment capable of providing a relatively clean bearing area. The bottom 6 inches of the excavations should be completed with a smooth-mouthed bucket or by hand labor. The excavations should be neatly excavated and properly formed. Debris in the bottom of the excavation should be removed prior to reinforcing steel placement. Water should not be allowed to accumulate at the bottom of the excavation.

To reduce the potential for groundwater seepage into the excavations and to minimize disturbance to the bearing area, we recommend that concrete and reinforcing steel be placed as soon as possible after the excavations are completed. Excavations should not be left open for more than 36 hours. The bearing surface of the grade beams should be evaluated after excavation is completed and immediately prior to placing concrete.

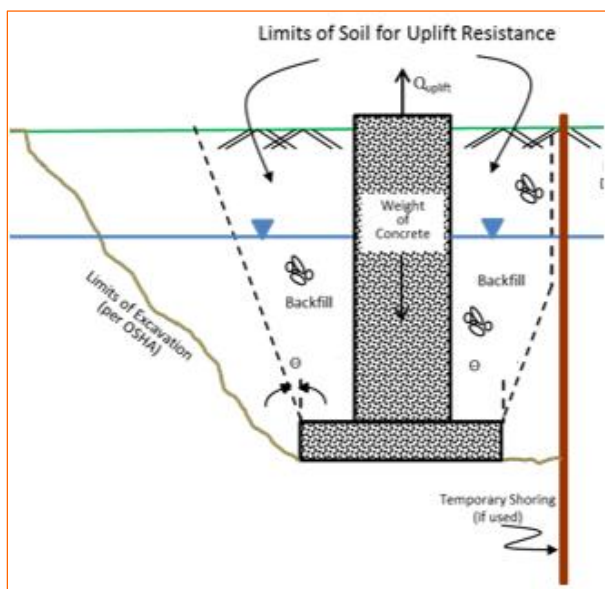
Strip/Spread Footing Foundation - Design Parameters

Strip/Spread footings may be considered in the design of the foundations to support the main column loads. Lateral loads transmitted to the footings should be resisted by a combination of soil-concrete friction on the base of the footing and passive pressure on the side of the footing. To resist lateral forces, a net allowable passive resistance may be utilized for portions of footings extending at least 30 inches below finished grade. If the footing is formed during construction, the open space between the footing and the in-situ soils should be backfilled with compacted select fill, lean concrete, compacted cement stabilized sand (two sacks cement to one cubic yard of

sand) or flowable fill. Also, care should be taken to avoid disturbance of the footing bearing area since loose material could increase settlement and decrease resistance to lateral loading.

The strip/spread footings can provide some uplift resistance for those structures subjected to wind or other induced structural loading.

Uplift resistance of strip/spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, ϕ , of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A soil unit weight of 120 pcf should be used for the backfill. This unit weight should be reduced to 40 pcf for portions of the backfill or natural soils below the groundwater elevation.



Design values for the footings are presented below.

| Item | Description |
|--|---|
| Minimum Embedment Below Finished Grade ¹ | 2½ feet |
| Net Allowable Bearing Pressure ⁷ | Total Load - 2,000 psf |
| Approximate total settlement ² | About ½ inch |
| Estimated Differential Settlement ³ | Approximately ½ of total settlement |
| Allowable Passive Pressure ⁴ | 500 psf (if considered) |
| Coefficient of Sliding Friction ⁵ | 0.40 |
| Uplift Resistance ⁶ | Foundation Weight (150 pcf) & Soil Weight (120 pcf) |

| Item | Description |
|------|---|
| 1. | To bear within the native soils or select fill. |
| 2. | This estimated post-construction settlement of the shallow footings is without considering the effect of stress distribution from adjacent foundations and assuming proper construction practices are followed. A clear distance between the footings of one footing size should not produce overlapping stress distributions and would essentially behave as independent foundations. |
| 3. | Differential settlement may result from variances in subsurface conditions, loading conditions and construction procedures. The settlement response of the footings will be more dependent upon the quality of construction than upon the response of the subgrade to the foundation loads. We estimate that the differential settlement should be approximately one-half of the total settlement. Settlement of footings will be more sensitive to installation techniques than to soil-structure interaction. |
| 4. | The passive pressure along the exterior of the footings should be neglected unless pavement is provided up to the edge of the structure. For interior footings, the allowable passive pressure may be used for the entire depth of the footing. The passive pressure provided above include a factor of safety of at least 3. |
| 5. | Lateral loads transmitted to the footings will be resisted by a combination of soil-concrete friction on the base of the footings and passive pressure on the side of the footings. |
| 6. | The ultimate uplift capacity of shallow footings should be reduced by an appropriate factor of safety to compute allowable uplift capacity. |
| 7. | The net allowable bearing pressure provided above include a factor of safety of at least 2. |

Construction Considerations for Strip/Spread Footing Foundation

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Excavation should be accomplished with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this bucket should be stopped 6 inches above the final bearing surface and the excavation completed with a smooth-mouthed bucket or by hand labor.

If the footing foundations are over-excavated and formed, the backfill around the foundation sides should be achieved with compacted select fill, lean concrete, compacted cement stabilized sand (two sacks cement to one cubic yard of sand) or flowable fill. Compaction of select fill should be as described later in this section of the report.

The bearing surface should be excavated with a slight slope to create an internal sump for runoff water collection and removal. If surface runoff water more than 2 inches accumulates at the bottom of the excavation, it should be pumped out prior to concrete placement. Under no circumstances should water be allowed to adversely affect the quality of the bearing surface. If the spread footing is buried, backfill above the foundation may be the excavated on-site soils or select fill soils. Backfill soils should be compacted to at least 95 percent of the maximum dry density as determined by the standard moisture/density relationship test (ASTM D 698). Moisture contents for on-site soils and imported select fill soils should be within 2 percentage points of the

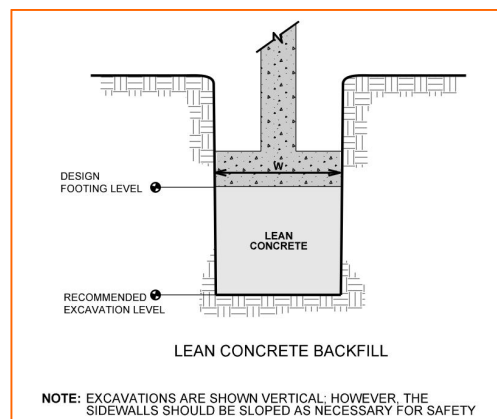
Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

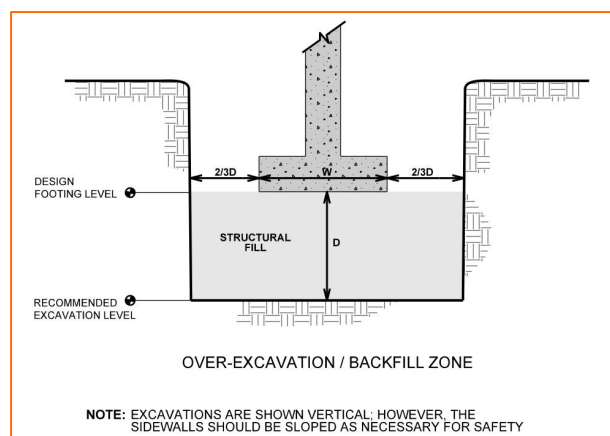
January 3, 2019 ■ Terracon Project No. 88185143

optimum moisture content. The backfill should be placed in thin, loose lifts of about 8 inches, with compacted thickness not to exceed 6 inches.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with select fill placed, as recommended in the **Earthwork** section.



MAT FOUNDATION

Mat Foundation System

A mat foundation may be considered for the planned pool structures at this site. The mat may be designed using the following net allowable bearing pressures:

| Net Allowable Bearing Pressures ¹ | Total Load ² |
|--|-------------------------|
| At 3 feet below FPE | 2,500 psf |
| At 8 feet below FPE | 5,000 psf |
| At 12.5 feet below FPE | 6,000 psf |

1. Below Finished Pad Elevation (FPE).

2. The net allowable bearing pressure provided above include a factor of safety of at least 2.

A subgrade modulus (k) of 120 pci on the prepared subgrade of compacted soil and/or granular base can be used. The modulus value may be adjusted for the actual mat size. Maximum contact pressure should not exceed the allowable net bearing pressure.

Uplift loading on the mat foundation can be resisted by the weight of the mat, the weight of structure, and any soil overlying the mat. A soil unit weight of 120 pounds per cubic foot (pcf) may be assumed for the on-site soils or select fill placed above the mat (if any), provided the select fill is properly compacted as recommended in this report. Criteria for select fill are discussed in the **Fill Material Types** section of this report. An ultimate coefficient of friction across the mat foundation base of 0.40 can be used to aid in the resistance of ground line shear.

Total settlements, both immediate and long-term, should be about ½ inch or less for a mat foundation designed for the indicated contact pressure. Differential settlements between the center and edge of the mat foundation should be on the order of ½ to ¾ of the total settlement. If the degree of movement indicated in this report is not tolerable, the mat foundation may be thickened to further increase its stiffness.

Construction Considerations for Mat Foundations

The mat should preferably be neatly excavated. Excavation should be accomplished with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this bucket should be stopped 6 inches above the final bearing surface and the excavation completed with a smooth-mouthed bucket or by hand labor. If neat excavation is not possible then the foundation should be over-excavated and formed. All loose materials should be removed from the over-excavated areas and filled with lean concrete or compacted cement stabilized sand (two sacks cement to one cubic yard of sand) or flowable fill.

To reduce the potential for water infiltration into the excavations and to minimize disturbance to the bearing area, we recommend that concrete and reinforcing steel be placed as soon as possible after the excavations are completed. Excavations should not be left open for more than 36 hours. The bearing surface should be evaluated after excavation is completed and immediately prior to placing concrete. If not, a seal slab consisting of lean concrete should be poured to protect the exposed foundation soils. The bearing surface should be excavated with a slight slope to create an internal sump for runoff water collection and removal.

If surface runoff water in excess of 1 inch accumulates at the bottom of the excavation, it should be pumped out prior to concrete placement. Under no circumstances should water be allowed to adversely affect the quality of the bearing surface.

DEEP FOUNDATIONS

Subsurface conditions at the site are generally suitable and practical for installation of straight sided (non-underreamed) piers to support principal column loads, reactions and moments for the structures. This report only discusses about straight sided piers.

Drilled Pier (DP) Design Parameters

The column loads of the proposed structures may be supported on piers bearing at approximately 10 feet below the Finished Pad Elevation (FPE). This depth was chosen to bear the piers below the active soil movement zone and allow adequate development of bearing capacity, resisting lateral loading conditions and to penetrate the piers into competent natural soils.

Design recommendations for drilled piers (DP) foundations for the proposed structure(s) are presented in the following paragraphs.

| Description | Design Parameters |
|--|-------------------------------------|
| Minimum Embedment Below FPE ^{1, 8} | 10 feet |
| Maximum Embedment Below FPE ^{1, 8} | 18 feet |
| Net Allowable Bearing Pressures (Total Load) ^{1, 2, 4} | |
| At a depth of 10 feet below FPE | 9,000 psf |
| Net Allowable Side-Shear ⁴ | |
| 5 to 10 feet below FPE | 600 psf |
| Minimum Percentage of Reinforcing Steel ³ | As required by structural engineer |
| Approximate Total Settlement ^{3, 5} | About ½ inch |
| Estimated Differential Settlement ^{5, 6} | Approximately ½ of total settlement |
| Allowable Passive Pressure ⁶ | |
| At a depth of 10 feet below FPE | 2,000 psf |

Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

January 3, 2019 ■ Terracon Project No. 88185143



| Description | Design Parameters |
|--|---|
| Estimated Uplift Pressure (kips) ^{6, 7} | Negligible |
| Estimated Uplift Resistance (kips) ⁶ | $2.8 \cdot d \cdot D_p + 0.9W_p + P_{DL}$ |
| Uplift Resistance ⁶ | Foundation Weight (150 pcf) & Soil Weight (120 pcf) |

1. For drilled piers to bear into the native soils.
2. Whichever condition yields a larger bearing area. These bearing pressures include a factor of safety against a bearing capacity failure of approximately 2.
3. The structural engineer should determine the required reinforcing steel throughout the entire shaft length of drilled pier to resist the axial and lateral forces.
4. A minimum center-to-center spacing between the piers equal to three times the pier diameter should be provided to develop the recommended allowable capacities for a single pier and to control settlements of the pier. If this clearance cannot be maintained for a given pair or within a single line of piers, the above allowable capacities for a single pier may need to be reduced. Also, large concentrated group of piers may have a reduced efficiency (decrease in load carrying capacity) even with the minimum pier spacing recommended previously. It is not recommended to have pier groups with elements closer than $2\frac{1}{2}$ times the pier diameter (center-to-center). The final foundation plan should be reviewed by Terracon to re-evaluate, if applicable, load carrying capacity and settlements, including the efficiency of pier groups. These allowable skin friction values include a minimum factor of safety of 2. The side shear should be neglected for the upper 5 feet of soil in contact with the pier shaft.
5. Will result from variances in subsurface conditions, loading conditions and construction procedures, such as cleanliness of the bearing area or flowing water in the shaft. Settlements provided for single, isolated piers only.
6. For piers placed against an undisturbed vertical face of the in-situ soils. Lateral resistance of the drilled piers is primarily developed by passive resistance of the soils against the side of the pier. Due to surface effects, the lateral resistance of the upper 5 feet from existing grade of the soils at the surface for exterior piers should be neglected unless area paving is provided around the piers. The passive pressure provided above include a factor of safety of at least 3.
7. The magnitude of uplift is difficult to predict and will vary with in-situ moisture contents. Additionally, structural uplift loads on the piers will be resisted by the dead weight of the piers and supported structure. For uplift resistance, we recommend total unit weights of 120 pounds per cubic foot (pcf) for soil and 150 pcf for reinforced concrete be utilized. The diameter of the pier shaft in feet should be used in place of "d".
8. Piers should bear no deeper than 18 feet below FPE without contacting our office.

The drilled pier parameters provided above are for calculating single pier capacities only.

For single, isolated drilled piers, total settlement, based on the indicated bearing pressures, should be about $\frac{1}{2}$ inch or less for properly designed and constructed drilled piers. Settlement beneath individual piers will be primarily elastic with most of the settlement occurring during construction. Differential settlement may also occur between adjacent piers. The amount of differential settlement between adjacent piers could approach 50 to 75 percent of the total pier settlement. Settlement response of drilled piers is impacted more by the quality of construction than by soil-structure interaction.

Improper pier installation could result in differential settlements significantly greater than we have estimated. In addition, larger magnitudes of settlement should be expected if the soil is subjected to bearing pressures higher than the allowable values presented in this report.

Drilled Pier Construction Considerations

The pier excavations should be augered and constructed in a continuous manner. Reinforcing steel and concrete should be placed in the pier excavations immediately following drilling and evaluation for proper bearing stratum, embedment, and cleanliness. Under no circumstances should the pier excavations remain open overnight.

Groundwater was not observed in the borings during drilling operations. See boring logs for detailed information. The contractor should be prepared to utilize casing techniques to control sloughing of the soil and the thick fill body during excavation if they occur and should verify the groundwater levels. The contractor should consider performing a “test” pier excavation to determine the constructability of a drilled pier with the dry auger process. The casing and slurry methods are discussed in the following paragraphs.

Casing Method: Casing should provide stability of the excavation walls and should reduce water influx; however, casing may not completely eliminate groundwater influx potential or stability of the pier excavation bottom unless the casing penetrates below any pervious soils. Casing that terminates in pervious soils may generate “boils” due to the head differential between the inside and outside of the casing and require that the casing be extended until the excess seepage or boils are eliminated. Also, in order for the casing to be effective, a “water tight” seal must be achieved between the casing and surrounding clay soils. The drilling subcontractor should determine casing depths and casing procedures. Water that accumulates in excess of 3 inches in the bottom of the pier excavation should be pumped out prior to reinforcing steel and concrete placement. If the water is not pumped out, a closed-end tremie should be used to place the concrete completely to the bottom of the pier excavation in a controlled manner to effectively displace the water during concrete placement. If water is not a factor, concrete may be placed with a short tremie so the concrete is directed to the bottom of the pier excavation. The concrete should not be allowed to ricochet off the walls of the pier excavation nor off the reinforcing steel. If this operation is not successful or to the satisfaction of the foundation contractor, the pier excavation should be flooded with fresh water to offset the differential water pressure caused by the unbalanced water levels inside and outside of the casing. The concrete should be tremied completely to the bottom of the excavation with a closed-end tremie.

Removal of casing should be performed with extreme care and under proper supervision to reduce mixing of the surrounding soil and water with the fresh concrete. Rapid withdrawal of casing or the auger may develop suction that could cause the soil to intrude into the excavation. An insufficient head of concrete in the casing during its withdrawal could also allow the soils to

intrude into the wet concrete. Both conditions may induce “necking”, a section of reduced diameter, in the pier.

Slurry Method: As an alternate to the use of casing to install the pier foundations, water or a weighted drilling fluid may be considered. Slurry displacement drilling can only prevent sloughing and water influx but cannot control sloughing once it has occurred. Therefore, slurry displacement drilling techniques must begin at the ground surface, not after sloughing materials are encountered.

Typical drilling fluids include those which contain polymers or bentonite. If a polymer is used with “hard” mixing water, a water softening agent may be required to achieve intimate mixing and the appropriate viscosity. The polymer manufacturer should be consulted concerning proper use of the polymer. If bentonite slurry is used, the bentonite should be mixed with water several hours before placing in the pier excavation.

Prior mixing gives the bentonite sufficient time to hydrate properly. The drilling fluid should only be of sufficient viscosity to control sloughing of the excavation walls and groundwater flow into the excavation. Care should be exercised while extracting the auger so that suction does not develop and cause disturbance or create “necking” in the excavation walls as described above. Casing should not be employed in conjunction with the slurry drilling technique due to possible trapping of loose soils and slurry between the concrete and natural soil. The use of weighted drilling fluid when installing drilled pier foundations requires extra effort to ensure an adequate bearing surface is obtained. A clean-out bucket should be used just prior to pier completion to remove any cuttings and loose soils which may have accumulated in the bottom of the excavation. Reinforcing steel and concrete should be placed in the excavation immediately after pier completion. A closed-end tremie should be used to place the concrete completely to the bottom of the excavation in a controlled manner to effectively displace the slurry during concrete placement.

When the pier excavation depth is achieved, and the bearing area has been cleaned, reinforcing steel and concrete should then be placed immediately in the excavation. The concrete should be placed completely to the bottom of the excavation with a closed-end tremie in the pier excavation if more than 6 inches of water is ponded on the bearing surface or the slurry drilling technique is used. A short tremie may be used if the excavation has less than 6 inches of ponded water or if the water is pumped out prior to concrete placement. The fluid concrete should not be allowed to strike the pier reinforcement, temporary casing (if required) or excavation sidewalls during concrete placement.

All aspects of concrete design and placement should comply with the American Concrete Institute (ACI) 318-14 Code Building Code Requirements for Structural Concrete; ACI 336.1-01 entitled Reference Specification for the Construction of Drilled Piers, and ACI 336.3R-14 entitled Report on Design and Construction of Drilled Piers. Concrete should be designed to achieve the specified 28-day strength when placed at a 7-inch slump with a ± 1 -inch tolerance. Adding water to a mix

Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

January 3, 2019 ■ Terracon Project No. 88185143



that has been designed for a lower slump does not meet the intent of this recommendation. If a high range water reducer is used to achieve this slump, the span of slump retention for the specific admixture under consideration should be thoroughly investigated. Compatibility with other concrete admixtures should also be considered. A technical representative of the admixture supplier should be consulted on these matters.

Successful installation of drilled piers is a coordinated effort involving the general contractor, design consultants, subcontractors and suppliers. Each must be properly equipped and prepared to provide their services in a timely fashion. Several key items of major concern are:

- Proper drilling rig with proper equipment (including casing and augers);
- Reinforcing steel cages tied to meet project specifications;
- Proper scheduling and ordering of concrete for the piers; and
- Monitoring of installation by design professionals.

Pier construction should be carefully monitored to assure compliance of construction activities with the appropriate specifications. Particular attention to the referenced publication is warranted for pier installation. Several items of concern for pier installation include those listed below.

- | | |
|---------------------------------|--|
| ■ Pier locations | ■ Concrete properties and placement |
| ■ Vertical alignment | ■ Proper casing seal for groundwater control |
| ■ Competent bearing | ■ Casing removal |
| ■ Reinforcement steel placement | ■ Slurry viscosity |

If the contractor has to deviate from the recommended foundations, Terracon should be notified immediately so additional engineering recommendations can be provided for an appropriate foundation type.

The existing facility (structures and subsurface utilities) should be observed prior to DP installation to document their condition. These structures should also be observed during DP installation for any indications of movement. Monitoring vibration levels during excavation and construction should be considered. Terracon can perform vibration monitoring upon request.

The DP process should be performed under the direction of the Geotechnical Engineer. The Geotechnical Engineer should document the DP installation process including soil and groundwater conditions encountered, consistency with expected conditions, and details of the installed deep foundation.

SWIMMING POOLS

The proposed swimming pool walls will be subject to lateral earth pressures induced by the soil retained by those walls. If the pool is constructed using “gunite” techniques, then the retained soil will be the natural soil encountered at the site. As such, the equivalent fluid density will be dictated by that natural soil.

If the soils are mass excavated and the swimming pool is formed and placed, then the backfill can consist of select materials such as clean sand or gravel, which will allow the equivalent fluid density exerted on the pool walls to be controlled to some extent. If the pool walls are backfilled, then a drainage system comprised of slotted or perforated PVC pipe encased by clean sand or gravel that is completely wrapped in filter fabric should be considered for behind-wall construction to further control the equivalent fluid density.

Lateral earth pressures on the below grade walls for the swimming pool may be determined using the parameters provided in the **Lateral Earth Pressure** section of this report.

We recommend that the walls of the pool be designed assuming no pressure from the water in the pool (that is, an empty pool). Installation of an effective subdrainage system is recommended to prevent development of hydrostatic lateral or buoyant pressures on the pool structure. This may include use of pre-fabricated drainage panels between the soil and the “gunite” and a properly graded granular drainage base with a properly outletted subdrain pipe. If the pool is formed and backfilled, a granular “chimney” drain could be used against the walls with a similar drainage base and subdrain pipe.

The permanent swimming pool walls should be designed for active to at-rest lateral earth pressures imposed by the backfill.

This pressure includes hydrostatic pressures but does not include surcharge pressure. For design purposes, we recommend groundwater levels be assumed at the ground surface, since this condition may exist after a heavy rainfall or flooding. The lateral surcharge pressure imposed by the floor slab may be computed as 0.7 times the floor slab loading on the ground surface and applied to the wall as a constant lateral pressure.

If the swimming pool is formed and backfilled, then a protective cover of at least 24 inches should be placed over the granular backfill to reduce the chance of surface run-off infiltration into the backfill materials. The protective cover should consist of relatively impervious, compacted soils. This cover should be moisture conditioned within 2 percentage points of the optimum moisture content. The on-site soils should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. The on-site soils should be placed in loose lifts of 8 inches with compacted thickness not exceeding 6 inches. Concrete flatwork constructed over the granular backfill can be considered for use as a protective cover in lieu of the compacted on-site soils.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 20 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

FLOOR SLABS

Information regarding existing and final grade elevation was not provided. We anticipate that finished floor elevation (FFE) may be at about 1½ feet above the existing grade. If significant fill or cuts are planned, Terracon should be notified to review and/or modify our recommendations given in this subsection.

The subsurface soils at this site generally exhibit low to moderate expansion potential. Based on the information developed from our field and laboratory programs and on method TEX-124-E in the Texas Department of Transportation (TxDOT) Manual of Testing Procedures, we estimate that the subgrade soils at this site exhibit a Potential Vertical Rise (PVR) of 1 inch or less in present condition.

The actual movements could be greater if poor drainage, ponded water, and/or other sources of moisture are allowed to infiltrate beneath the structure after construction. We have provided recommendations to maintain the site PVR to about 1 inch or less. In addition, positive structure perimeter drainage should be carefully observed.

After site stripping and over-excavation activities as recommended, place the select fill over a moisture conditioned and compacted fill body. The building pad should be constructed directly below the floor slab and should also extend a minimum of 3 feet beyond the edge of the proposed structure area, including any movement sensitive flatwork that abuts the structure such as sidewalks. The final exterior grade adjacent to the structure should be sloped to promote positive drainage away from the structure.

The subgrade and select fill soils should be prepared as outlined in the **Earthwork** section of this report, which contains material and placement requirements for select fill, as well as other subgrade preparation recommendations. The floor slab should be designed using the following recommendations.

Floor Slab Design Parameters

| Item | Description |
|--|---|
| Excavation | Minimum 24 inches. |
| Floor Slab Support ¹ | Min. 12 inches of moisture conditioned and compacted native soils plus 1½ feet of select fill as needed to achieve Finished Building Pad Elevation. |
| Estimated Modulus of Subgrade Reaction ² | 125 pounds per square inch per inch (psi/in) for point loads. |
| Estimated Potential Vertical Rise (PVR) | Less than 1 inch |

1. Floor slabs should be structurally independent of structure footings or walls (if any) to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

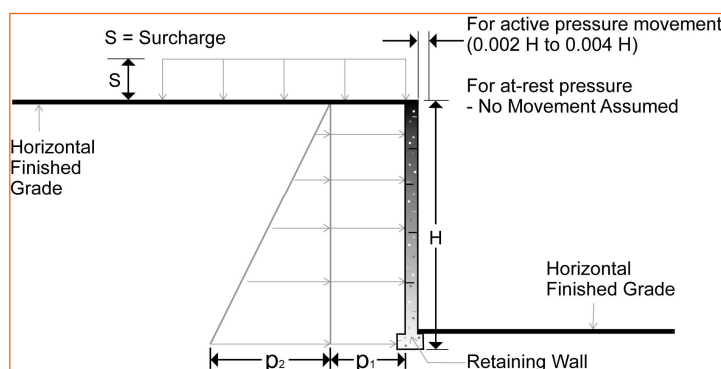
Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



| Lateral Earth Pressure Design Parameters | | | | |
|--|-------------------------------|--|---|------------------------|
| Earth Pressure Condition ¹ | Coefficient for Backfill Type | Surcharge Pressure ^{2, 3, 4} p_1 (psf) | Effective Fluid Pressures (psf) ^{4, 5} | |
| | | | Unsaturated ⁶ | Submerged ⁶ |
| Active (K_a) | Granular - 0.27 | (0.27)S | (35)H | (81)H |
| | On-Site Soil - 0.41 | (0.41)S | (49)H | (86)H |
| At-Rest (K_o) | Granular - 0.43 | (0.43)S | (55)H | (91)H |
| | On-Site Soil - 0.58 | (0.58)S | (69)H | (96)H |
| Passive (K_p) | Granular - 3.69 | --- | (480)H | (312)H |
| | On-Site Soil - 2.46 | --- | (296)H | (204)H |

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.

2. Uniform surcharge, where S is surcharge pressure.

3. Loading from heavy compaction equipment is not included in surcharge or earth pressures.

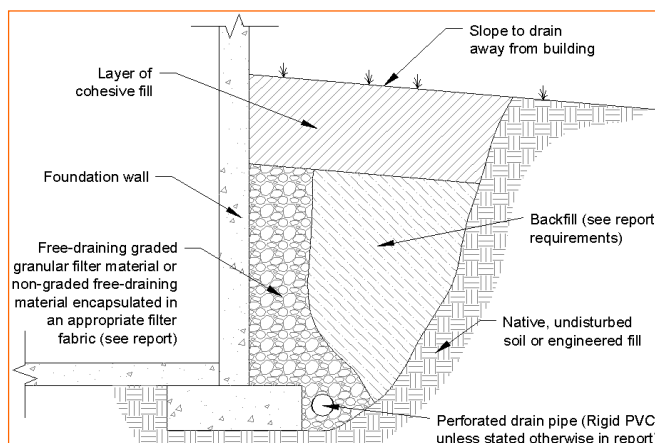
| Lateral Earth Pressure Design Parameters | | | | |
|--|-------------------------------|--|---|------------------------|
| Earth Pressure Condition ¹ | Coefficient for Backfill Type | Surcharge Pressure ^{2, 3, 4} p_1 (psf) | Effective Fluid Pressures (psf) ^{4, 5} | |
| | | | Unsaturated ⁶ | Submerged ⁶ |

4. No safety factor is included in these values.
5. Uniform, final graded backfill, compacted to at least 95 percent of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf.
6. In order to achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively. To calculate the resistance to sliding, a value of 0.40 should be used as the ultimate coefficient of friction between the footing and the underlying soil.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

PAVEMENTS

Both flexible and rigid pavements may be considered for this project. Pavement subgrade preparations are included in this section to limit changes in soil moisture conditions to help mitigate the effects of soil movement. However, even if these recommendations are followed some pavement distress could still occur.

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, must be applied to the site, which has been prepared as recommended in the **Site Preparation** section.

We recommend the moisture content and density of the top 6 inches of the subgrade be evaluated and the pavement subgrade be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and re-compacted.

Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Based on the subsurface conditions, we anticipate that the pavement subgrade will generally consist of the on-site soils. The top 6 inches of the finished subgrade soils directly beneath the pavements may be chemically treated. Chemical treatment will increase the supporting value of the subgrade and decrease the effect of moisture on subgrade soils. These 6 inches of treatment should be considered as required part of the pavement design and is not a part of site and subgrade preparation for wet/soft subgrade conditions.

If chemical treatment of the subgrade is chosen, we anticipate that the on-site surficial soils should be treated with about 3 percent of lime or cement (modifier). This percentage is given as application by dry weight and is typically equivalent to about 15 pounds of modifier per square yard per 6-inch depth. The recommended percentage of modifier is for estimating and planning.

The actual quantity of modifier required should be determined at the time of construction by laboratory tests on bulk samples of the subgrade soils. Specifications for treated subgrade are presented later in this section. Alternative pavement sections without treated subgrade is also provided.

After proofrolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in **Earthwork** section of this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Pavement Design Considerations

Traffic patterns and anticipated loading conditions were not available at the time this report was prepared. However, we anticipate that traffic loads will be produced primarily by light traffic, delivery and trash removal trucks. Pavement thickness can be determined using AASHTO, Asphalt Institute and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided.

Terracon can provide thickness recommendations for pavements subjected to loads other than the above-mentioned traffic if this information is provided.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to parking lots and drives should slope down from pavement edges at a minimum 2%;
- The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote proper surface drainage;
- Install pavement drainage surrounding areas anticipated for frequent wetting (e.g., garden centers, wash racks);
- Install joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to pavements to reduce moisture migration to subgrade soils;
- Place compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Place curb, gutter and/or sidewalk directly on low permeability subgrade soils rather than on unbound granular base course materials.

Estimated Minimum Pavement Thickness

As a minimum, we recommend the following typical pavement sections be considered.

| Pavement Area | Traffic Design Index | Description |
|-----------------------------------|----------------------|--|
| Automobile Parking Areas | DI-1 | Light traffic (Few vehicles heavier than passenger cars, no regular use by heavily loaded two axle trucks). (EAL ⁽¹⁾ < 6) |
| Driveways | DI-2 | Light to medium traffic (Similar to DI-1 including not over 50 loaded two axle trucks or lightly loaded larger vehicles per day. No regular use by heavily loaded trucks with three or more axles). (EAL = 6-20) |
| Driveways for Truck Traffic Areas | DI-3 | Medium to heavy traffic (Including not over 300 heavily loaded two axle trucks plus lightly loaded trucks with three or more axles and no more than 30 heavily loaded trucks with more than three axles per day). (EAL = 21-75) |

1. Equivalent daily 18-kip single-axle load applications.

Listed below are pavement component thicknesses, which may be used as a guide for pavement systems at the site for the traffic classifications stated herein. These systems were derived based on general characterization of the subgrade. Specific testing (such as CBR's, resilient modulus tests, etc.) was not performed for this project to evaluate the support characteristics of the subgrade.

| Minimum Recommended <u>Flexible</u> Pavement Section Thickness, inches | | |
|--|-------------------|-------------------|
| Component | DI-1 ¹ | DI-2 ¹ |
| Hot Mix Asphaltic Concrete (HMAC) ^{2, 3} | 2 | 2½ |
| Granular Base Material ² | 6 | 8 |
| Treated Subgrade ² | 6 | 6 |

1. See **Pavements** for more specifics regarding traffic information.

2. All materials should meet the current Department of Transportation (TxDOT) Standard Specifications for Highway and Bridge Construction.

3. A minimum 2-inch surface course should be used on Asphaltic Cement Concrete (ACC) pavements.

| Alternative Minimum Recommended <u>Flexible</u> Pavement System, inches | | |
|--|--------------------------|--------------------------|
| Component | DI-1 ¹ | DI-2 ¹ |
| Hot Mix Asphaltic Concrete (HMAC) ^{2, 3} | 2 | 2½ |
| Granular Base Material ² | 8 | 10 |
| Moisture Conditioned Subgrade | 6 | 6 |

1. See **Pavements** for more specifics regarding traffic information.

2. All materials should meet the current Department of Transportation (TxDOT) Standard Specifications for Highway and Bridge Construction.

3. A minimum 2-inch surface course should be used on ACC pavements.

| Minimum Recommended <u>Rigid</u> Pavement Section Thickness, inches | | | |
|--|--------------------------|--------------------------|-----------------------------|
| Component | DI-1 ¹ | DI-2 ¹ | DI-3 ^{1, 3} |
| Reinforced PC Concrete ² | 5 | 6 | 7 |
| Granular Base Material ³ | 4 | 4 | 4 |
| Moisture Conditioned Subgrade | 6 | 6 | 6 |

1. See **Pavements** for more specifics regarding traffic information.

2. All materials should meet the current Department of Transportation (TxDOT) Standard Specifications for Highway and Bridge Construction. Concrete Pavement - TxDOT Portland Cement Concrete Class P or applicable ACI standards.

3. In areas of anticipated heavy traffic or concentrated loads (e.g. dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles. Six (6) inches of treated subgrade may be used instead of 4 inches of granular base material.

The listed pavement component thicknesses should be used as a guide for pavement systems at the site for the traffic classifications stated herein. These recommendations assume a 20-year pavement design life. If pavement frequencies or loads will be different than that specified Terracon should be contacted and allowed to review these pavement sections.

We recommend a Portland Cement Concrete (PCC) pavement be utilized in the main access lanes, parking lots, dumpster pads or other areas where extensive wheel maneuvering are expected.

We recommend that waste dumpster areas be constructed of at least 7 inches of reinforced concrete pavement. The concrete pad areas should be designed so that the vehicle wheels of the collection truck are supported on the concrete while the dumpster is being lifted to support the large wheel loading imposed during waste collection.

Although not required for structural support of rigid pavement systems, a base course layer may be considered to help reduce potentials for slab curl, shrinkage cracking, and subgrade “pumping” through joints.

Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Presented below are our recommended material requirements for the various pavement sections.

Reinforced Concrete Pavement: The materials and properties of reinforced concrete pavement shall meet applicable requirements in the ACI Manual of Concrete Practice. The Portland cement concrete mix should have a minimum 28-day compressive strength of 4,000 psi.

Reinforcing Steel: Reinforcing steel should consist of the following:

DI-1: #3 bars spaced at 18 inches or #4 bars spaced at 24 inches on centers in both directions.

DI-2: #3 bars spaced at 12 inches or #4 bars spaced at 18 inches on centers in both directions.

DI-3: #4 bars spaced at 12 inches on centers in both directions.

Control Joint Spacing: ACI recommendations indicate that control joints should be spaced at about 30 times the thickness of the pavement. Furthermore, ACI recommends a maximum control joint spacing of 12.5 feet for 5-inch pavements and a maximum control joint spacing of 15 feet for 6-inch or thicker pavements. Saw cut control joints should be cut within 6 to 12 hours of concrete placement or as soon as it is practical.

Expansion Joint Spacing: ACI recommendations indicate that regularly spaced expansion joints may be deleted from concrete pavements. Therefore, the installation of expansion joints is optional and should be evaluated by the design team.

Dowels at Expansion Joints: The dowels at expansion joints should be spaced at 12-inch centers and consist of the following:

DI-1: 5/8-inch diameter, 12-inches long with 5-inch embedment

DI-2: 3/4-inch diameter, 14-inches long with 6-inch embedment

DI-3: 7/8-inch diameter, 14-inches long with 6-inch embedment

Hot Mix Asphaltic Concrete Surface Course: The asphaltic concrete surface course should be plant mixed, hot laid Type C or D (Fine Graded Surface Course) meeting the specifications

requirements in 2014 TxDOT Standard Specifications Item 340. Specific criteria for the job specifications should include compaction to within an air void range of 5 to 9 percent calculated using the maximum theoretical gravity mix measured by TxDOT Tex-227-F. The asphalt cement content by percent of total mixture weight should be within ± 0.5 percent asphalt cement from the job mix design.

Granular Base Material: Granular base material should be composed of crushed limestone or crushed concrete meeting the requirements of 2014 TxDOT Standard Specifications Item 247, Type A or D, Grades 1-2 and/or 3.

As an alternate to the Type A base, treated “caliche” material meeting the requirements of 2014 TxDOT Standard Specification Manual Item 247, Type B, Grades 1-2 and/or 3 may be used.

The granular base should be compacted to at least 95 percent of the maximum dry density determined in accordance with the modified moisture-density relationship (ASTM D 1557) at moisture content within 2 percentage points of the optimum moisture content.

Treated Subgrade: The subgrade soils should be treated with lime or cement in accordance with 2014 TxDOT Standard Specifications Items 260 or 275. The recommended percentage of modifier is for estimating and planning. The actual quantity of modifier required should be determined at the time of construction by laboratory tests on bulk samples of the subgrade soils.

If chemical treatment of the subgrade is chosen, we anticipate that the on-site surficial soils be treated with about 3 percent of lime or cement (modifier). This percentage is given as application by dry weight and is typically equivalent to about 15 pounds of modifier per square yard per 6-inch depth. The subgrade should be compacted to a minimum of 95 percent of the Standard Effort (ASTM D 698) maximum dry density within 2 percentage points of the optimum moisture content. Preferably, traffic, should be kept off the treated subgrade for about 3 to 5 days to facilitate curing of the soil - chemical mixture; in addition, the subgrade is not suitable for heavy construction traffic prior to paving.

Post-construction subgrade movements and some cracking of the pavements are not uncommon for subgrade conditions such as those observed at this site. Although chemical treatment of the subgrade will help to reduce such movement/cracking, this movement/cracking cannot be economically eliminated.

Moisture Conditioned Subgrade: The subgrade should be scarified to a depth of 8 inches and moisture conditioned within 2 percentage points of the optimum moisture content. The subgrade should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. This should result in a compacted, moisture conditioned layer about 6 inches thick.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program.

Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

FROST CONSIDERATIONS

The soils on this site are not frost susceptible. However, amounts of water can affect the performance of the floor slabs and sidewalks. If frost action needs to be eliminated, we recommend the use of Non-Frost Susceptible (NFS) fill. Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave, if this occurs:

- Provide surface drainage away from the building and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs and pavements, and connect them to the storm drainage system.
- Grade clayey subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs and pavements critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.
- Place NFS materials in critical sidewalk areas.

As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

SULFATE CONSIDERATIONS

Sulfate tests were performed on selected soil samples collected from the project site. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction and chemical reaction with the pavement modifiers. Test locations and depths were chosen to provide a range of test locations regards to depth.

Sulfate content concentrations for some of the borings along with their location and approximate depth are as follow:

| Sulfate Test Results Summary | | | | |
|------------------------------|--------|--------------------|----------------------|----------------------|
| Location | Boring | Sample Depth, feet | Soil Description | Sulfate Content, ppm |
| Outdoor 25 yd x 25 m Pool | B-3 | 4½ - 6 | Sandy Lean Clay (CL) | 346 |
| Diving Pool | B-5 | 2 - 4 | Sandy Lean Clay (CL) | < 100 |

Results of soluble sulfate testing indicate samples of the on-site soils tested possess negligible to moderate sulfate concentrations when classified in accordance with ACI standards. Using the criteria from ACI 201.2R, the test results were classified as Class 0 and 1 exposure. Concrete should be designed in accordance with the applicable provisions of the ACI Design Manual.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of

Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

January 3, 2019 ■ Terracon Project No. 88185143



pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

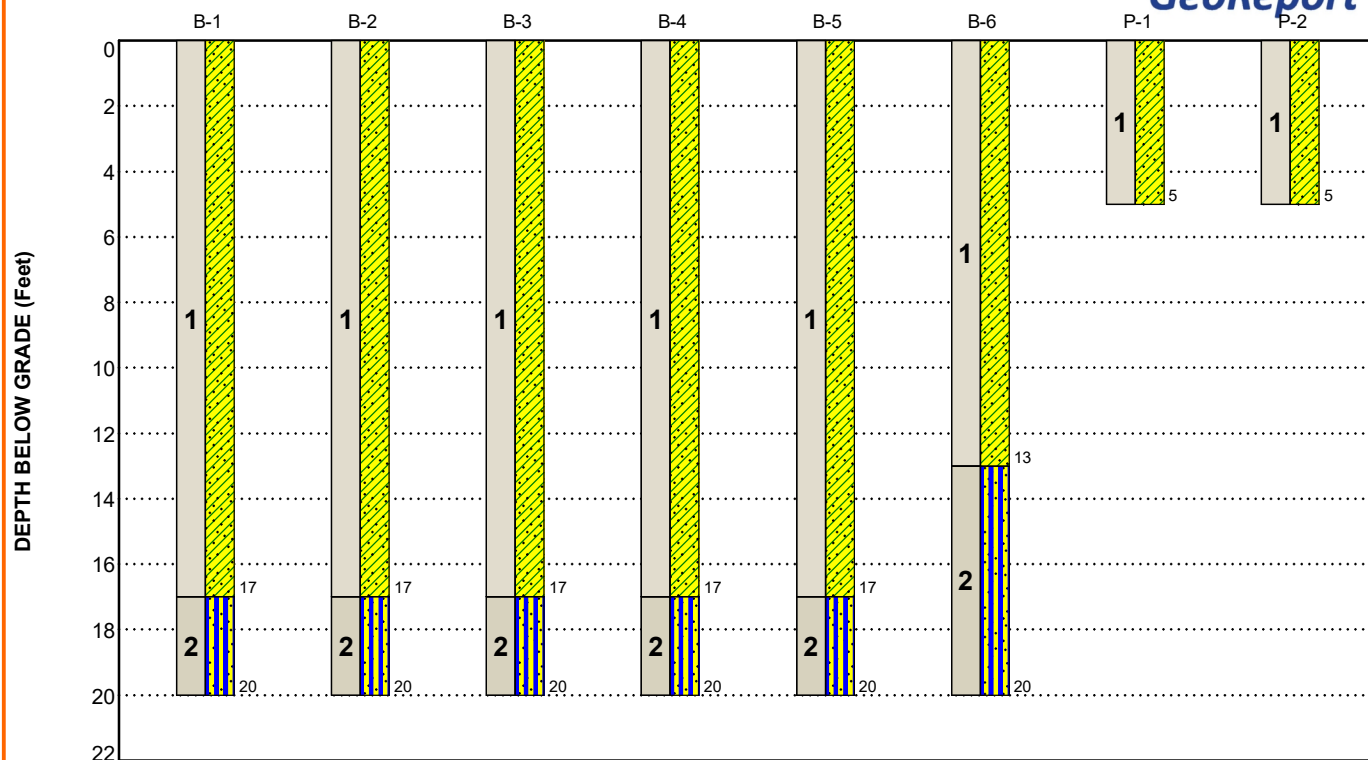
FIGURES

Contents:

GeoModel

GEOMODEL


PSJA Early College HS - Outdoor Pool ■ San Juan, Texas
1/3/2019 ■ Terracon Project No. 88185143






This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

| Model Layer | Layer Name | General Description |
|-------------|------------|---|
| 1 | SANDY CLAY | Sandy Lean Clay (CL), soft to very stiff |
| 2 | SANDY SILT | Sandy Silt (ML), non-plastic, loose to medium dense |

LEGEND

 Sandy Lean Clay

 Sandy Silt

-  First Water Observation
-  Second Water Observation
-  Final Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

| Number of Borings | Boring Depth (feet) ¹ | Planned Location |
|-------------------|----------------------------------|---------------------------|
| 2 | 20 | Outdoor 25 yd x 25 m Pool |
| 1 | 20 | Diving Pool |
| 1 | 20 | Instructional Pool |
| 2 | 20 | Building Areas |
| 2 | 5 | Pavements |

¹. Below ground surface.

The drilling depths were based on topographic conditions at the time of our drilling operations.

Boring Layout and Elevations: Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ± 10 feet).

Subsurface Exploration Procedures: We advanced the soil borings with a truck-mounted drill rig using continuous flight augers (solid stem and/or hollow stem as necessary depending on soil conditions). Five samples were obtained in the upper 10 feet of the borings and at intervals of 5 feet thereafter. Soil sampling was performed using thin-wall tube and/or split-barrel sampling procedures. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, the borings were backfilled with auger cuttings after their completion.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a geotechnical engineer. Our exploration team prepared field boring logs as part of the drilling operations. The field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field log. The final boring logs represent the geotechnical engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned various laboratory tests to better understand the engineering properties of the various soil strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards

Geotechnical Engineering Report

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

January 3, 2019 ■ Terracon Project No. 88185143



noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas
January 3, 2019 ■ Terracon Project No. 88185143

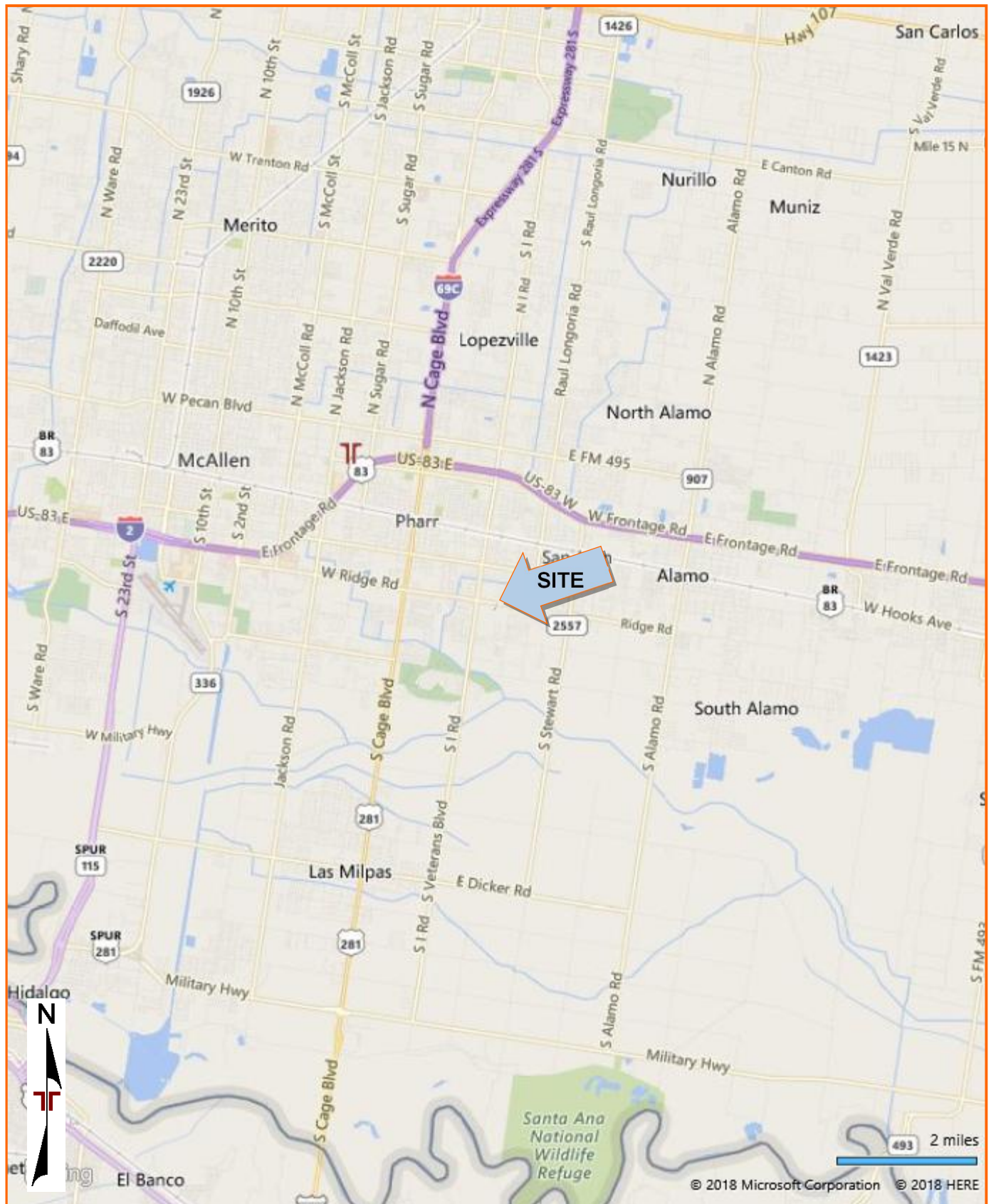


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS
NOT INTENDED FOR CONSTRUCTION PURPOSES

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas
January 3, 2019 ■ Terracon Project No. 88185143



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS
NOT INTENDED FOR CONSTRUCTION PURPOSES

EXPLORATION RESULTS

Contents:

Boring Logs

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.17715° Longitude: -98.165792° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|---|--------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | SANDY LEAN CLAY (CL) , brown to light reddish brown, soft to very stiff | 5 | | | 3-3-2 N=5 | | | | 11 | | 35-16-19 | |
| | | | | | | 2-1-2 N=3 | | | | 14 | | | |
| | | | | | | 2-3-5 N=8 | | | | 15 | | 38-16-22 | |
| | | | | | | 4-7-13 N=20 | | | | 14 | | | 65 |
| | | | | | | 7-10-13 N=23 | | | | 14 | | | |
| | | | | | | 6-8-11 N=19 | | | | 12 | | 38-16-22 | |
| 2 | | SANDY SILT (ML) , non-plastic, light brown, medium dense | 17.0 20.0 | | | 3-5-5 N=10 | | | | 14 | | | 68 |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Drill Rig: CME 55

Project No.: 88185143

Boring Completed: 12-12-2018

Driller: SWD

BORING LOG NO. B-2

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.177047° Longitude: -98.165593° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|--|--------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | SANDY LEAN CLAY (CL) , brown to light reddish brown, medium stiff to very stiff | 5 | | | 5-3-3 N=6 | | | | 9 | | | 53 |
| | | | | | | 2-3-3 N=6 | | | | 13 | | 35-15-20 | |
| | | | | | | 4-5-4 N=9 | | | | 14 | | | |
| | | | | | | 4-7-9 N=16 | | | | 13 | | 39-17-22 | |
| | | | | | | 4-6-8 N=14 | | | | 12 | | | |
| | | | | | | 6-9-15 N=24 | | | | 15 | | 40-17-23 | |
| 2 | | SANDY SILT (ML) , non-plastic, light brown, medium dense | 17.0 20.0 | | | 7-9-9 N=18 | | | | 13 | | | 55 |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Drill Rig: CME 55

Project No.: 88185143

Boring Completed: 12-12-2018

Driller: SWD

BORING LOG NO. B-3

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.177072° Longitude: -98.1659° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS | PERCENT FINES |
|-------------|-------------|---|-------------|-----------------------------|-------------|-----------------------|---------------|----------------------------------|------------|----------------------|--------------------------|---------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | LL-PL-PI | |
| 1 | | SANDY LEAN CLAY (CL) , brown to light reddish brown, medium stiff to very stiff | 5 | | | 4-3-2 N=5 | | | | 11 | | 36-14-22 | 70 |
| | | | | | | 3-4-5 N=9 | | | | 15 | | | |
| | | | | | | 6-6-7 N=13 | | | | 11 | | 41-18-23 | |
| | | | | | | 6-11-15 N=26 | | | | 12 | | | |
| | | | | | | 6-7-11 N=18 | | | | 12 | | 35-15-20 | |
| | | | | | | 6-9-13 N=22 | | | | 11 | | | |
| 2 | | SANDY SILT (ML) , non-plastic, light brown, loose | 20 | | | 5-4-5 N=9 | | | | 15 | | | 72 |
| | | Boring Terminated at 20 Feet | | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Drill Rig: CME 55

Project No.: 88185143

Boring Completed: 12-12-2018

Driller: SWD

BORING LOG NO. B-4

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.176867° Longitude: -98.165716° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|--|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | SANDY LEAN CLAY (CL) , brown to light reddish brown, medium stiff to very stiff | 5 | | | 3-4-5 N=9 | | | | 8 | | | |
| | | | | | | 3-3-3 N=6 | | | | 12 | | 38-17-21 | |
| | | | | | | 5-4-5 N=9 | | | | 9 | | 38-16-22 | |
| | | | | | | 8-12-15 N=27 | | | | 14 | | | |
| | | | | | | 9-11-13 N=24 | | | | 9 | | | 68 |
| | | | | | | | | | | | | | |
| 2 | | SANDY SILT (ML) , non-plastic, light reddish brown, loose | 15 | | | 9-10-12 N=22 | | | | 12 | | | |
| | | | | | | 5-3-5 N=8 | | | | 16 | | | 64 |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 20 feet.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Boring Completed: 12-12-2018

Drill Rig: CME 55

Driller: SWD

Project No.: 88185143

BORING LOG NO. B-5

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.176777° Longitude: -98.16578° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|---|--------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | SANDY LEAN CLAY (CL) , brown to light reddish brown, medium stiff to very stiff | 5 | | | 5-4-4 N=8 | | | | 8 | | 34-15-19 | 70 |
| | | | | | | 3-3-3 N=6 | | | | 11 | | | |
| | | | | | | 4-5-5 N=10 | | | | 12 | | 38-17-21 | |
| | | | | | | 5-7-10 N=17 | | | | 14 | | | |
| | | | | | | 6-9-13 N=22 | | | | 13 | | | |
| | | | | | | 5-9-10 N=19 | | | | 15 | | 43-18-25 | |
| 2 | | SANDY SILT (ML) , non-plastic, light brown, medium dense | 17.0 20.0 | | | 5-5-7 N=12 | | | | 14 | | | |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 20 feet.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Boring Completed: 12-12-2018

Drill Rig: CME 55

Driller: SWD

Project No.: 88185143

BORING LOG NO. B-6

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.176801° Longitude: -98.165919° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|--|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | SANDY LEAN CLAY (CL) , brown to light reddish brown, medium stiff to very stiff | 5 | | | 6-6-5 N=11 | | | | 8 | | 45-18-27 | 72 |
| | | | | | | 4-4-3 N=7 | | | | 13 | | | |
| | | | | | | 5-5-6 N=11 | | | | 12 | | | |
| | | | | | | 3-5-9 N=14 | | | | 13 | | | |
| | | | | | | 5-9-11 N=20 | | | | 14 | | | |
| | | | | | | | | | | | | | |
| 2 | | SANDY SILT (ML) , non-plastic, light reddish brown, medium dense | 15 | | | 5-4-6 N=10 | | | | 15 | | | 64 |
| | | | | | | 3-4-6 N=10 | | | | 12 | | | |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 20 feet.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Boring Completed: 12-12-2018

Drill Rig: CME 55

Driller: SWD

Project No.: 88185143



BORING LOG NO. P-1

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.177445° Longitude: -98.165788° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS | PERCENT FINES |
|-------------|---|--|-------------|--------------------------|---|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | LL-PL-PI | |
| 1 |  | SANDY LEAN CLAY (CL) , brown, medium stiff to stiff | 5.0 | |  | 3-3-2 N=5 | | | | 10 | | | |
| | | | | | | | | | | | | | |
| | | | | | | 2-3-6 N=9 | | | | 11 | | 39-16-23 | |
| | | Boring Terminated at 5 Feet | | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 5 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Drill Rig: CME 55

Project No.: 88185143

Boring Completed: 12-12-2018

Driller: SWD



BORING LOG NO. P-2

Page 1 of 1

PROJECT: PSJA Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
Pharr, Texas

SITE: 805 W. Ridge Road
San Juan, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.177455° Longitude: -98.165333° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS | PERCENT FINES |
|-------------|---|--|-------------|--------------------------|---|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | LL-PL-PI | |
| 1 |  | SANDY LEAN CLAY (CL) , brown, medium stiff | 5.0 | |  | 3-3-3 N=6 | | | | 13 | | 40-15-25 | |
| | | | | | | | | | | | | | |
| | | | | | | 2-2-3 N=5 | | | | 12 | | | 65 |
| | | Boring Terminated at 5 Feet | | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Dry augered from 0 to 5 feet.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-12-2018

Boring Completed: 12-12-2018

Drill Rig: CME 55

Driller: SWD

Project No.: 88185143

SUPPORTING INFORMATION

Contents:

General Notes

Unified Soil Classification System





Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

PSJA Early College HS - Outdoor Pool ■ San Juan, Texas

January 3, 2019 ■ Terracon Project No. 88185143

| SAMPLING | WATER LEVEL | FIELD TESTS |
|---|---|--|
|  Split Spoon |  Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time <p>Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.</p> | <p>N Standard Penetration Test Resistance (Blows/Ft.)</p> <p>(HP) Hand Penetrometer</p> <p>(T) Torvane</p> <p>(DCP) Dynamic Cone Penetrometer</p> <p>UC Unconfined Compressive Strength</p> <p>(PID) Photo-Ionization Detector</p> <p>(OVA) Organic Vapor Analyzer</p> |

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

| RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance | | CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance | | |
|---|---|---|---|---|
| Descriptive Term (Density) | Standard Penetration or N-Value Blows/Ft. | Descriptive Term (Consistency) | Unconfined Compressive Strength Qu, (tsf) | Standard Penetration or N-Value Blows/Ft. |
| Very Loose | 0 - 3 | Very Soft | less than 0.25 | 0 - 1 |
| Loose | 4 - 9 | Soft | 0.25 to 0.50 | 2 - 4 |
| Medium Dense | 10 - 29 | Medium Stiff | 0.50 to 1.00 | 4 - 8 |
| Dense | 30 - 50 | Stiff | 1.00 to 2.00 | 8 - 15 |
| Very Dense | > 50 | Very Stiff | 2.00 to 4.00 | 15 - 30 |
| | | Hard | > 4.00 | > 30 |

| RELATIVE PROPORTIONS OF SAND AND GRAVEL | | RELATIVE PROPORTIONS OF FINES | |
|---|--------------------------------------|---|-----------------------|
| Descriptive Term(s) of other constituents | Percent of Dry Weight | Descriptive Term(s) of other constituents | Percent of Dry Weight |
| Trace | <15 | Trace | <5 |
| With | 15-29 | With | 5-12 |
| Modifier | >30 | Modifier | >12 |
| GRAIN SIZE TERMINOLOGY | | PLASTICITY DESCRIPTION | |
| Major Component of Sample | Particle Size | Term | Plasticity Index |
| Boulders | Over 12 in. (300 mm) | Non-plastic | 0 |
| Cobbles | 12 in. to 3 in. (300mm to 75mm) | Low | 1 - 10 |
| Gravel | 3 in. to #4 sieve (75mm to 4.75 mm) | Medium | 11 - 30 |
| Sand | #4 to #200 sieve (4.75mm to 0.075mm) | High | > 30 |
| Silt or Clay | Passing #200 sieve (0.075mm) | | |

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A | | | | | Soil Classification | |
|--|--|---|---|--------|------------------------------------|------------------------------------|
| | | | | | Group Symbol | Group Name ^B |
| Coarse-Grained Soils: More than 50% retained on No. 200 sieve | Gravels: More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels: Less than 5% fines ^C | Cu ³ 4 and 1 £ Cc £ 3 ^E | GW | Well-graded gravel ^F | |
| | | | Cu < 4 and/or [Cc<1 or Cc>3.0] ^E | GP | Poorly graded gravel ^F | |
| | | Gravels with Fines: More than 12% fines ^C | Fines classify as ML or MH | GM | Silty gravel ^{F, G, H} | |
| | | | Fines classify as CL or CH | GC | Clayey gravel ^{F, G, H} | |
| | Sands: 50% or more of coarse fraction passes No. 4 sieve | Clean Sands: Less than 5% fines ^D | Cu ³ 6 and 1 £ Cc £ 3 ^E | SW | Well-graded sand ^I | |
| | | | Cu < 6 and/or [Cc<1 or Cc>3.0] ^E | SP | Poorly graded sand ^I | |
| | | Sands with Fines: More than 12% fines ^D | Fines classify as ML or MH | SM | Silty sand ^{G, H, I} | |
| | | | Fines classify as CL or CH | SC | Clayey sand ^{G, H, I} | |
| Fine-Grained Soils: 50% or more passes the No. 200 sieve | Silts and Clays: Liquid limit less than 50 | Inorganic: | PI > 7 and plots on or above “A” | CL | Lean clay ^{K, L, M} | |
| | | | PI < 4 or plots below “A” line ^J | ML | Silt ^{K, L, M} | |
| | | Organic: | Liquid limit - oven dried | < 0.75 | OL | Organic clay ^{K, L, M, N} |
| | | | Liquid limit - not dried | | Organic silt ^{K, L, M, O} | |
| | Silts and Clays: Liquid limit 50 or more | Inorganic: | PI plots on or above “A” line | CH | Fat clay ^{K, L, M} | |
| | | | PI plots below “A” line | MH | Elastic Silt ^{K, L, M} | |
| | | Organic: | Liquid limit - oven dried | < 0.75 | OH | Organic clay ^{K, L, M, P} |
| | | | Liquid limit - not dried | | Organic silt ^{K, L, M, Q} | |
| Highly organic soils: | Primarily organic matter, dark in color, and organic odor | | | PT | Peat | |

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$^E Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains ³ 15% sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains ³ 15% gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

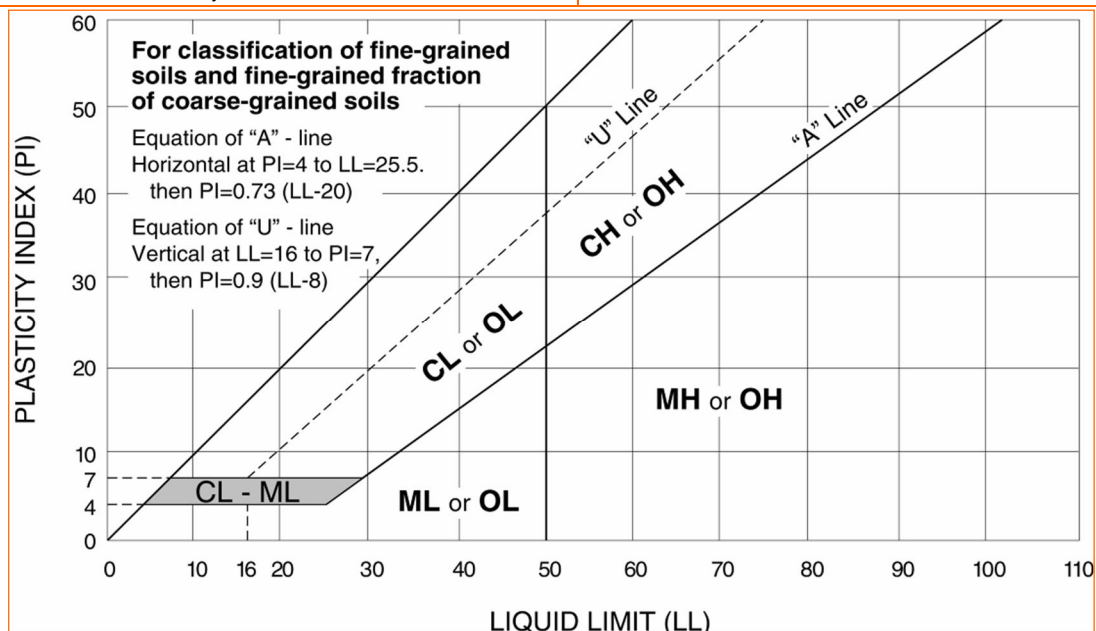
^M If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

^N PI ³ 4 and plots on or above "A" line.

^O PI < 4 or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.





Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool
Alamo, Texas

January 10, 2019

Terracon Project No. 88185144

Prepared for:

Pharr-San Juan-Alamo ISD
San Juan, Texas

Prepared by:

Terracon Consultants, Inc.
Pharr, Texas



January 10, 2019

Pharr-San Juan-Alamo ISD
601 East Kelly Street
San Juan, Texas 78577



Attn: Mr. Jerry Lopez
P: (956) 684 6384
E: gerardo.lopez@psjaisd.us

Re: Geotechnical Engineering Report
PSJA Memorial Early College HS - Outdoor Pool
800 S. Alamo Road
Alamo, Texas
Terracon Project No. 88185144

Dear Mr. Lopez:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P88185144 dated November 15, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork, design and construction of foundations and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.
(Texas Firm Registration No.: F-3272)


Martin Reyes
Senior Staff Engineer




Alfonso A. Soto, P.E., D.GE.
Principal

REPORT TOPICS

| | |
|------------------------------------|----|
| INTRODUCTION..... | 1 |
| SITE CONDITIONS..... | 1 |
| PROJECT DESCRIPTION..... | 2 |
| GEOTECHNICAL CHARACTERIZATION..... | 3 |
| GEOTECHNICAL OVERVIEW | 3 |
| EARTHWORK..... | 4 |
| SHALLOW FOUNDATIONS..... | 8 |
| MAT FOUNDATION..... | 10 |
| DEEP FOUNDATIONS | 11 |
| SWIMMING POOLS..... | 16 |
| SEISMIC CONSIDERATIONS | 17 |
| FLOOR SLABS..... | 17 |
| LATERAL EARTH PRESSURES | 19 |
| PAVEMENTS..... | 21 |
| FROST CONSIDERATIONS..... | 27 |
| GENERAL COMMENTS..... | 28 |
| FIGURES | 29 |

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the **GeoReport** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

| Topic ¹ | Overview Statement ² |
|--------------------------------------|---|
| Project Description | Single-story building and outdoor pool complex. |
| Geotechnical Characterization | <ul style="list-style-type: none"> ■ Groundwater was not observed either during or upon completion of drilling operations. ■ The subsurface soils at this site generally consist of Fat Clay (CH) to termination of borings. |
| Potential Vertical Rise (PVR) | The existing Potential Vertical Rise (PVR) of the soils within the proposed building and swimming pool areas in present condition is about 2½ inches. |
| Seismic Site Classification | The subsurface conditions within the site are consistent with the characteristics of Site Class D as defined in the International Building Code (IBC) Site Classification. |
| Foundations | A shallow and/or deep foundation system would be appropriate to support the structural loads of the proposed structures, provided the pads are prepared as recommended in this report. |
| Below-Grade Structures | Pool walls may be designed as either cantilevered or restrained retaining walls. |
| Earthwork | The subgrade should be prepared as noted in Earthwork . |
| Pavements | <p>Flexible and rigid pavement systems may be considered for this project. We anticipate traffic may consist primarily of small vehicles, midsize trucks and occasional garbage trucks.</p> <p>The subgrade should be prepared as noted in Earthwork, flexible pavement sections vary from 2 to 3 inches of Hot Mix Asphaltic Concrete (HMAC) over 6 to 10 inches of granular base material with treated subgrade or moisture conditioned subgrade. The rigid pavement system varies from 5 to 7 inches of reinforced concrete with moisture conditioned subgrade.</p> |
| General Comments | This section contains important information about the limitations of this geotechnical engineering report. |

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report
PSJA Memorial Early College HS - Outdoor Pool
800 S. Alamo Road
Alamo, Texas
Terracon Project No. 88185144
January 10, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed PSJA Early College HS - Outdoor Pool to be located at 800 S. Alamo Road in Alamo, Texas. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Swimming pool
- Excavation considerations
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Lateral earth pressures
- Pavement design and construction
- Frost considerations

The geotechnical engineering Scope of Services for this project included the advancement of 8 test borings to depths ranging from approximately 6 to 20 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic maps.

| Item | Description |
|--------------------|---|
| Parcel Information | The project is located at 800 S. Alamo Road in Alamo, Texas. Approx. GPS coordinates: Latitude: 26.172286° N Longitude: -98.122071° W. See Site Location |

Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144



| Item | Description |
|-----------------------|---|
| Existing Improvements | Undeveloped land. |
| Current Ground Cover | Earthen and lightly vegetated. |
| Existing Topography | Relatively flat and level. |
| Geology | The Geologic Atlas of Texas (1976), McAllen - Brownsville sheet has mapped the In-Rio Grande Delta, clay veneer over meander belt sand Formation (Qbv) of the Quaternary age at or near this site. The soils are mostly composed of clay and sand, floodplain deposits mud veneer over meander belt sands, little grain preserved (part of Beaumont Formation). |

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

| Item | Description |
|---------------------------------|---|
| Information Provided | By Mr. David Iglesias with PBK on November 14, 2018. |
| Project Description | Single-story building and outdoor pool complex. |
| Proposed Structures | The project will include the construction of a single-story building and a pool complex that consist of three (3) swimming pools: outdoor 25 yd x 25 m, instructional and diving pools. The pool water depths may vary from 3 feet for shallow water areas to 12.5 feet or greater for diving areas. Development may also include construction of flexible and/or rigid pavements for the main access lanes and parking area. |
| Building Construction | We anticipate that the building will likely consist of pre-engineered metal structure with CMU, brick veneer or stucco exterior walls supported by a shallow or deep foundation system. |
| Finished Floor Elevation (FFE) | Information was not provided at this time. |
| Maximum Loads (assumed) | <ul style="list-style-type: none">■ Columns: 30 kips■ Walls: 3 kips per linear foot■ Slabs: 250 pounds per square foot |
| Grading/Slopes | Up to 1 foot of cut and 2 feet of fill may be required to develop final grade. |
| Below-Grade Areas | Swimming pools. |
| Pavements | Flexible and rigid pavements may be considered for this project. |
| Estimated Start of Construction | Information was not provided at this time. |

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs and the GeoModel can be found in the **Exploration Results** and in the **Figures** sections of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

| Model Layer | Layer Name | General Description |
|-------------|------------|--------------------------------|
| 1 | Fat Clay | Fat Clay, medium stiff to hard |

Groundwater Conditions

The boreholes were drilled to their full depths using dry drilling techniques to aid in the observation of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration that the borings were allowed to remain open. The boreholes can be found on the boring logs in **Exploration Results**.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. The boreholes were backfilled with on-site soil cuttings after completion of the groundwater level observations.

GEOTECHNICAL OVERVIEW

Our findings indicate the proposed building structure can be supported on a shallow or deep foundation system. The desired foundation system may be used at this site provided the site and foundation are designed and constructed as recommended in this report.

The suitability and performance of a soil supported foundation for a structure depends on many factors including the magnitude of soil movement expected, the type of structure, the intended use of the structure, the construction methods available to stabilize the soils, and our understanding of the owner's expectations of the completed structure's performance.

Expansive soils are present on this site. This report provides recommendations to help mitigate the effects of soil settlement, shrinkage and expansion. However, even if these procedures are followed,

Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144



some movement in the structure should be anticipated. Eliminating the risk of movement may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of data presented herein, engineering analyses, and our current understanding of the proposed project.

The **General Comments** section provides an understanding of the report limitations.

Swell Tests

Swell tests were performed on soil samples from a boring drilled at the site. After surcharge pressures were applied the samples were inundated with water for about 72 to 96 hours while measurements of vertical displacement were taken. The magnitude of swell is recorded as a function of the change in thickness during the test in relation to the initial thickness of the sample.

Based on our laboratory results, the sample tested exhibited a free swell ranging between 1.9 and 7.0 percent between 2 to 8 feet. When equivalent overburden pressure was applied, the resulting swell was ranging between 0.6 and 5.3 percent. The summary of test results is presented in the **Attachments** section of this report.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Construction areas should be stripped of all vegetation, topsoil and other unsuitable material. Additional excavation as recommended in this report or as needed should be performed within the proposed building and pool areas. Once final subgrade elevation has been achieved, the exposed subgrade should be carefully proofrolled with a 15-ton pneumatic roller or a fully loaded dump truck to detect weak zones in the subgrade. Special care should be exercised when proofrolling the fill soils to detect soft/weak areas. Weak areas detected during proofrolling, as well as zones of fill containing organic matter and/or debris should be removed and replaced with select fill in the proposed building and pool areas. Proper site drainage should be maintained

during construction, so that ponding of surface runoff does not occur and cause construction delays and/or inhibit site access.

Subsequent to proofrolling, and just prior to placement of fill, the exposed subgrade within the construction area should be evaluated for moisture and density. If the moisture, density, and/or the requirements do not meet the criteria described in the table below, the subgrade should be scarified to a minimum depth of 8 inches, moisture adjusted and compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density. Select fill should meet the following criteria.

Fill Material Types

Engineered fill should consist of approved materials, free of organic material, debris and particles larger than about 2 inches. The maximum particle size criteria may be relaxed by the geotechnical engineer of record depending on construction techniques, material gradation, allowable lift thickness and observations during fill placement. Soils for use as engineered fill material should conform to the following specifications:

| Fill Type ¹ | USCS Classification | Acceptable Location for Placement |
|---|--|---|
| Aggregate Base Course ² | SC, GC, Caliche, Crushed Limestone, Crushed Concrete | Top 6 inches of building pad area. |
| Select Fill | CL and/or SC (7≤PI≤20) | Must be used to construct the building pad, pavements and all grade adjustments within the construction area. |
| On-Site Soils | CH | On-site soils CH are not suitable for use as fill within the building area, but may be used within the pavement and landscaping areas as long as they are free from organics and construction debris. |

1. Prior to any filling operations, samples of the proposed borrow and on-site materials should be obtained for laboratory moisture-density testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to evaluate that proper levels of compaction, including dry unit weight and moisture content, are being attained.

2. Crushed limestone and crushed concrete material should meet the requirements of 2014 TxDOT Item 247, Type A, or D, Grades 1-2 and/or 3. The select fill materials should be free of organic material and debris and should not contain stones larger than 2 inches in the maximum dimension. The clayey gravel and caliche materials should meet the gradation requirements of Item 247, Type B, Grades 1-2 and/or 3 as specified in the 2014 TxDOT Standard Specifications Manual and a Plasticity Index between 7 and 20.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

| Item | Description |
|--|---|
| Fill Lift Thickness | The fill should be placed in loose lifts of about 8 inches, with compacted thickness not exceeding 6 inches. |
| Compaction Requirements (on-site soils, subgrade) | The on-site soils should be compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density within 4 percentage points above of optimum moisture content. |
| Compaction Requirements (select fill and aggregate base course) | The on-site soils and select fill should be compacted to at least 95 percent of The Standard Effort (ASTM D698) maximum dry density within 2 percentage points of the optimum moisture content. |

Wet Weather/Soft Subgrade Considerations

Construction operations may encounter difficulties due to the wet or soft surface soils becoming a general hindrance to equipment due to rutting and pumping of the soil surface, especially during and soon after periods of wet weather.

If the subgrade cannot be adequately compacted to minimum densities as described above, one of the following measures will be required:

- Removal and replacement with select fill,
- Chemical treatment of the soil to dry and increase the stability of the subgrade, or
- Drying by natural means if the schedule allows.

In our experience with similar soils in this area, chemical treatment is the most efficient and effective method to increase the supporting value of wet and weak subgrade. Terracon should be contacted for additional recommendations if chemical treatment of the soils is needed.

Prior to placing any fill, all surface vegetation, topsoil, possible fill material and any otherwise unsuitable materials should be removed from the construction areas. Wet or dry material should either be removed, or moisture conditioned and recompacted. After stripping and grubbing, the subgrade should be proof-rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a 15-ton roller or fully loaded dump truck. Soft, dry and low-density soil should be removed or compacted in place prior to placing fill.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Planters and other surface features which could retain water in areas adjacent to the building(s) should be sealed or eliminated. In areas where sidewalks or

paving do not immediately adjoin the structures, we recommend that protective slopes be provided with a minimum grade of approximately 3 percent for at least 10 feet from perimeter walls, except in areas where ADA ramps are required, these areas should comply with state and local regulations. Backfill against exterior walls, and in utility and sprinkler line trenches, should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Downspouts, roof drains or scuppers should discharge into extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Consideration should be given to extending drainage piping to day light at the face of curbs then empty onto pavement surfaces. Sprinkler systems should not be installed within 5 feet of foundation walls. Landscaped irrigation adjacent to the foundation systems should be minimized or eliminated.

Where paving or flatwork abuts the structure(s), effectively seal and maintain joints to prevent surface water infiltration. The joint between the sidewalk curb and building(s) should be sealed. The sidewalk curb along the building line is recommended to prevent water from standing over the joint between the building and sidewalk should the outside edge of the slab rise due to soil swelling at the sidewalk edge.

Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the structures should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the structures.

We recommend constructing an effective clay "trench plug" that extends at least 5 feet out from the perimeter. The plug material should consist of clay compacted at a water content at or above the soils optimum water content. The clay fill should be placed to surround the utility line and be compacted in accordance with recommendations in this report.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The groundwater table could affect overexcavation efforts, especially for over-excavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps could be necessary to achieve the recommended depth of over-excavation.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

Based upon the subsurface conditions observed during our investigation a shallow (slab-and-grade) foundation system would be appropriate to support the structural loads of the proposed structures provided the subgrade is prepared as discussed in this report. Recommendations for this type of foundation system is provided in the following sections, along with other geotechnical considerations for this project.

Due to expansive soils encountered at this site, spread footings are not considered as a foundation alternative. However, the grade beams may be thickened and widened where necessary to support column loads. The settlement is usually the controlling factor in the decision

to use spread footings. Settlement may increase depending on the type of soils, moisture content, and the applied stress.

The slab-on-grade foundation may be designed using the following parameters provided the subgrade is prepared as outlined in the **Earthwork** and **Floor Slabs** sections of this report:

Slab-on-Grade Foundation - Design Parameters

| Item | Description |
|--|---|
| Select Fill Pad | Minimum 3½ feet of select fill over 6 inches of moisture conditioned and compacted on-site soils. |
| Allowable Bearing Pressure ¹ n Compacted Select Fill | Net Total Load - 3,000 psf |
| Climatic Rating | 15 |
| Design Plasticity Index | 29 |
| Soil Support Index | 0.85 |
| Estimated PVR ² | About 1 inch |
| Approximate Total Settlement ³ | About ½ inch |
| Estimated Differential Settlement ³ | Approximately ½ of total settlement |
| Min. Perimeter Grade Beam Embedment ⁴ | 18 inches below finished grade |

1. The net allowable bearing pressure provided above include a factor of safety of at least 2.
2. The slab-on-grade foundation system should be designed to tolerate the anticipated soil movement and provide satisfactory support to the proposed structures. The foundation should have adequate exterior and interior grade beams to provide sufficient rigidity to the foundation system such that the slab deflections that result are considered tolerable to the supported structures.
3. This estimated post-construction settlement is assuming proper construction practices are followed. Settlement response of a select fill supported slab is influenced more by the quality of construction than by soil-structure interaction. Therefore, it is essential that the recommendations for foundation construction be strictly followed during the construction phases of the pad and foundation.
4. To bear within the select fill or moisture conditioned and recompacted on-site soils. The grade beams may be thickened and widened where necessary to support column loads.

Construction Considerations for Slab-on-grade Foundation

Excavations for grade beams should be performed with equipment capable of providing a relatively clean bearing area. The bottom 6 inches of the excavations should be completed with a smooth-mouthed bucket or by hand labor. The excavations should be neatly excavated and properly formed. Debris in the bottom of the excavation should be removed prior to reinforcing steel placement. Water should not be allowed to accumulate at the bottom of the excavation.

To reduce the potential for groundwater seepage into the excavations and to minimize disturbance to the bearing area, we recommend that concrete and reinforcing steel be placed as

soon as possible after the excavations are completed. Excavations should not be left open for more than 36 hours. The bearing surface of the grade beams should be evaluated after excavation is completed and immediately prior to placing concrete.

Flatwork

Grade supported flatwork adjacent to the building will be subjected to the movements of swelling soils unless proper measures are taken. Differential movement between the flatwork and building may result in a trip hazard. Consideration should be given to supporting the flatwork on select fill. The existing Potential Vertical Rise (PVR) of the soils within the proposed building area in present condition is about 2½ inches. Heave of flatwork could be greater due to the moderate surcharge imposed on the subgrade.

Preparing the flatwork as recommended for the building area and placement of select fill will help reduce the PVR to about 1 inch. If measures are not taken to address differential movement in the design stage, this issue may become a constant maintenance issue during the life of the building. Proper drainage of the site is also important and is addressed in this report.

MAT FOUNDATION

Mat Foundation System

A mat foundation may be considered for the planned pool structures at this site. The mat may be designed using the following net allowable bearing pressures:

| Net Allowable Bearing Pressures ¹ | Total Load ² |
|--|-------------------------|
| At 3 feet below FPE | 3,000 psf |
| At 8 feet below FPE | 5,000 psf |
| At 12.5 feet below FPE | 6,000 psf |

1. Below Finished Pad Elevation (FPE).

2. The net allowable bearing pressure provided above include a factor of safety of at least 2.

3. Excavate a minimum of 24 inches below the proposed mat foundation elevation. This should result in at least 24 inches of select fill or aggregate base course beneath each mat foundation.

A subgrade modulus (k) of 120 pci on the prepared subgrade of compacted soil and/or granular base can be used. The modulus value may be adjusted for the actual mat size. Maximum contact pressure should not exceed the allowable net bearing pressure.

Uplift loading on the mat foundation can be resisted by the weight of the mat, the weight of structure, and any soil overlying the mat. A soil unit weight of 120 pounds per cubic foot (pcf) may be assumed for the on-site soils or select fill placed above the mat (if any), provided the select fill is properly compacted as recommended in this report. Criteria for select fill are discussed in the

Fill Material Types section of this report. An ultimate coefficient of friction across the mat foundation base of 0.40 can be used to aid in the resistance of ground line shear.

Total settlements, both immediate and long-term, should be about ½ inch or less for a mat foundation designed for the indicated contact pressure. Differential settlements between the center and edge of the mat foundation should be on the order of ½ to ¾ of the total settlement. If the degree of movement indicated in this report is not tolerable, the mat foundation may be thickened to further increase its stiffness.

Construction Considerations for Mat Foundations

The mat should preferably be neatly excavated. Excavation should be accomplished with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this bucket should be stopped 6 inches above the final bearing surface and the excavation completed with a smooth-mouthed bucket or by hand labor. If neat excavation is not possible then the foundation should be over-excavated and formed. All loose materials should be removed from the over-excavated areas and filled with lean concrete or compacted cement stabilized sand (two sacks cement to one cubic yard of sand) or flowable fill.

To reduce the potential for water infiltration into the excavations and to minimize disturbance to the bearing area, we recommend that concrete and reinforcing steel be placed as soon as possible after the excavations are completed. Excavations should not be left open for more than 36 hours. The bearing surface should be evaluated after excavation is completed and immediately prior to placing concrete. If not, a seal slab consisting of lean concrete should be poured to protect the exposed foundation soils. The bearing surface should be excavated with a slight slope to create an internal sump for runoff water collection and removal.

If surface runoff water in excess of 1 inch accumulates at the bottom of the excavation, it should be pumped out prior to concrete placement. Under no circumstances should water be allowed to adversely affect the quality of the bearing surface.

DEEP FOUNDATIONS

Subsurface conditions at the site are generally suitable and practical for installation of straight sided (non-underreamed) piers to support principal column loads, reactions and moments for the structures. This report only discusses about straight sided piers.

Drilled Pier (DP) Design Parameters

The column loads of the proposed structures may be supported on piers bearing at approximately 15 feet below the Finished Pad Elevation (FPE). This depth was chosen to bear the piers below

Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144



the active soil movement zone and allow adequate development of bearing capacity, resisting lateral loading conditions and to penetrate the piers into competent natural soils.

Design recommendations for drilled piers (DP) foundations for the proposed structure(s) are presented in the following paragraphs.

| Description | Design Parameters |
|--|---|
| Minimum Embedment Below FPE ^{1, 8} | 15 feet |
| Maximum Embedment Below FPE ^{1, 8} | 18 feet |
| Net Allowable Bearing Pressures (Total Load) ^{1, 2, 4} | |
| At a depth of 15 feet below FPE | 9,000 psf |
| Net Allowable Side-Shear ⁴ | |
| 5 to 15 feet below FPE | 600 psf |
| Minimum Percentage of Reinforcing Steel ³ | As required by structural engineer |
| Approximate Total Settlement ^{3, 5} | About ½ inch |
| Estimated Differential Settlement ^{5, 6} | Approximately ½ of total settlement |
| Allowable Passive Pressure ⁶ | |
| At a depth of 15 feet below FPE | 2,100 psf |
| Estimated Uplift Pressure (kips) ^{6, 7} | 14 • d |
| Estimated Uplift Resistance (kips) ⁶ | $2.8 \cdot d \cdot D_p + 0.9W_p + P_{DL}$ |
| Uplift Resistance ⁶ | Foundation Weight (150 pcf) & Soil Weight (120 pcf) |

Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144



| Description | Design Parameters |
|--|-------------------|
| <ol style="list-style-type: none">1. For drilled piers to bear into the native soils.2. Whichever condition yields a larger bearing area. These bearing pressures include a factor of safety against a bearing capacity failure of approximately 2.3. The structural engineer should determine the required reinforcing steel throughout the entire shaft length of drilled pier to resist the axial and lateral forces.4. A minimum center-to-center spacing between the piers equal to three times the pier diameter should be provided to develop the recommended allowable capacities for a single pier and to control settlements of the pier. If this clearance cannot be maintained for a given pair or within a single line of piers, the above allowable capacities for a single pier may need to be reduced. Also, large concentrated group of piers may have a reduced efficiency (decrease in load carrying capacity) even with the minimum pier spacing recommended previously. It is not recommended to have pier groups with elements closer than 2½ times the pier diameter (center-to-center). The final foundation plan should be reviewed by Terracon to re-evaluate, if applicable, load carrying capacity and settlements, including the efficiency of pier groups. These allowable skin friction values include a minimum factor of safety of 2. The side shear should be neglected for the upper 5 feet of soil in contact with the pier shaft.5. Will result from variances in subsurface conditions, loading conditions and construction procedures, such as cleanliness of the bearing area or flowing water in the shaft. Settlements provided for single, isolated piers only.6. For piers placed against an undisturbed vertical face of the in-situ soils. Lateral resistance of the drilled piers is primarily developed by passive resistance of the soils against the side of the pier. Due to surface effects, the lateral resistance of the upper 5 feet from existing grade of the soils at the surface for exterior piers should be neglected unless area paving is provided around the piers. The passive pressure provided above include a factor of safety of at least 3.7. The magnitude of uplift is difficult to predict and will vary with in-situ moisture contents. Additionally, structural uplift loads on the piers will be resisted by the dead weight of the piers and supported structure. For uplift resistance, we recommend total unit weights of 120 pounds per cubic foot (pcf) for soil and 150 pcf for reinforced concrete be utilized. The diameter of the pier shaft in feet should be used in place of "d".8. Piers should bear no deeper than 18 feet below FPE without contacting our office. | |

The drilled pier parameters provided above are for calculating single pier capacities only.

For single, isolated drilled piers, total settlement, based on the indicated bearing pressures, should be about ½ inch or less for properly designed and constructed drilled piers. Settlement beneath individual piers will be primarily elastic with most of the settlement occurring during construction. Differential settlement may also occur between adjacent piers. The amount of differential settlement between adjacent piers could approach 50 to 75 percent of the total pier settlement. Settlement response of drilled piers is impacted more by the quality of construction than by soil-structure interaction.

Improper pier installation could result in differential settlements significantly greater than we have estimated. In addition, larger magnitudes of settlement should be expected if the soil is subjected to bearing pressures higher than the allowable values presented in this report.

Drilled Pier Construction Considerations

The pier excavations should be augered and constructed in a continuous manner. Reinforcing steel and concrete should be placed in the pier excavations immediately following drilling and evaluation for proper bearing stratum, embedment, and cleanliness. Under no circumstances should the pier excavations remain open overnight.

Groundwater was not observed in the borings during drilling operations. See boring logs for detailed information. The contractor should be prepared to utilize casing techniques to control sloughing of the soil and the thick fill body during excavation if they occur and should verify the groundwater levels. The contractor should consider performing a “test” pier excavation to determine the constructability of a drilled pier with the dry auger process. The casing method is discussed in the following paragraphs.

Casing Method: Casing should provide stability of the excavation walls and should reduce water influx; however, casing may not completely eliminate groundwater influx potential or stability of the pier excavation bottom unless the casing penetrates below any pervious soils. In order for the casing to be effective, a “water tight” seal must be achieved between the casing and surrounding clay soils. The drilling subcontractor should determine casing depths and casing procedures. Water that accumulates in excess of 3 inches in the bottom of the pier excavation should be pumped out prior to reinforcing steel and concrete placement. If the water is not pumped out, a closed-end tremie should be used to place the concrete completely to the bottom of the pier excavation in a controlled manner to effectively displace the water during concrete placement. If water is not a factor, concrete may be placed with a short tremie so the concrete is directed to the bottom of the pier excavation. The concrete should not be allowed to ricochet off the walls of the pier excavation nor off the reinforcing steel. If this operation is not successful or to the satisfaction of the foundation contractor, the pier excavation should be flooded with fresh water to offset the differential water pressure caused by the unbalanced water levels inside and outside of the casing. The concrete should be tremied completely to the bottom of the excavation with a closed-end tremie.

Removal of casing should be performed with extreme care and under proper supervision to reduce mixing of the surrounding soil and water with the fresh concrete. Rapid withdrawal of casing or the auger may develop suction that could cause the soil to intrude into the excavation. An insufficient head of concrete in the casing during its withdrawal could also allow the soils to intrude into the wet concrete. Both conditions may induce “necking”, a section of reduced diameter, in the pier.

When the pier excavation depth is achieved, and the bearing area has been cleaned, reinforcing steel and concrete should then be placed immediately in the excavation. The concrete should be placed completely to the bottom of the excavation with a closed-end tremie in the pier excavation if more than 6 inches of water is ponded on the bearing surface or the slurry drilling technique is

used. A short tremie may be used if the excavation has less than 6 inches of ponded water or if the water is pumped out prior to concrete placement. The fluid concrete should not be allowed to strike the pier reinforcement, temporary casing (if required) or excavation sidewalls during concrete placement.

All aspects of concrete design and placement should comply with the American Concrete Institute (ACI) 318-14 Code Building Code Requirements for Structural Concrete; ACI 336.1-01 entitled Reference Specification for the Construction of Drilled Piers, and ACI 336.3R-14 entitled Report on Design and Construction of Drilled Piers. Concrete should be designed to achieve the specified 28-day strength when placed at a 7-inch slump with a ± 1 -inch tolerance. Adding water to a mix that has been designed for a lower slump does not meet the intent of this recommendation. If a high range water reducer is used to achieve this slump, the span of slump retention for the specific admixture under consideration should be thoroughly investigated. Compatibility with other concrete admixtures should also be considered. A technical representative of the admixture supplier should be consulted on these matters.

Successful installation of drilled piers is a coordinated effort involving the general contractor, design consultants, subcontractors and suppliers. Each must be properly equipped and prepared to provide their services in a timely fashion. Several key items of major concern are:

- Proper drilling rig with proper equipment (including casing and augers);
- Reinforcing steel cages tied to meet project specifications;
- Proper scheduling and ordering of concrete for the piers; and
- Monitoring of installation by design professionals.

Pier construction should be carefully monitored to assure compliance of construction activities with the appropriate specifications. Particular attention to the referenced publication is warranted for pier installation. Several items of concern for pier installation include those listed below.

- | | |
|---------------------------------|--|
| ■ Pier locations | ■ Concrete properties and placement |
| ■ Vertical alignment | ■ Proper casing seal for groundwater control |
| ■ Competent bearing | ■ Casing removal |
| ■ Reinforcement steel placement | ■ Slurry viscosity |

If the contractor has to deviate from the recommended foundations, Terracon should be notified immediately so additional engineering recommendations can be provided for an appropriate foundation type.

The existing facility (structures and subsurface utilities) should be observed prior to DP installation to document their condition. These structures should also be observed during DP installation for

any indications of movement. Monitoring vibration levels during excavation and construction should be considered. Terracon can perform vibration monitoring upon request.

The DP process should be performed under the direction of the Geotechnical Engineer. The Geotechnical Engineer should document the DP installation process including soil and groundwater conditions encountered, consistency with expected conditions, and details of the installed deep foundation.

SWIMMING POOLS

The proposed swimming pool walls will be subject to lateral earth pressures induced by the soil retained by those walls. If the pool is constructed using “gunite” techniques, then the retained soil will be the natural soil encountered at the site. As such, the equivalent fluid density will be dictated by that natural soil.

If the soils are mass excavated and the swimming pool is formed and placed, then the backfill can consist of select materials such as clean sand or gravel, which will allow the equivalent fluid density exerted on the pool walls to be controlled to some extent. If the pool walls are backfilled, then a drainage system comprised of slotted or perforated PVC pipe encased by clean sand or gravel that is completely wrapped in filter fabric should be considered for behind-wall construction to further control the equivalent fluid density.

Lateral earth pressures on the below grade walls for the swimming pool may be determined using the parameters provided in the **Lateral Earth Pressure** section of this report.

We recommend that the walls of the pool be designed assuming no pressure from the water in the pool (that is, an empty pool). Installation of an effective subdrainage system is recommended to prevent development of hydrostatic lateral or buoyant pressures on the pool structure. This may include use of pre-fabricated drainage panels between the soil and the “gunite” and a properly graded granular drainage base with a properly outletted subdrain pipe. If the pool is formed and backfilled, a granular “chimney” drain could be used against the walls with a similar drainage base and subdrain pipe.

The permanent swimming pool walls should be designed for active to at-rest lateral earth pressures imposed by the backfill.

This pressure includes hydrostatic pressures but does not include surcharge pressure. For design purposes, we recommend groundwater levels be assumed at the ground surface, since this condition may exist after a heavy rainfall or flooding. The lateral surcharge pressure imposed by the floor slab may be computed as 0.7 times the floor slab loading on the ground surface and applied to the wall as a constant lateral pressure.

If the swimming pool is formed and backfilled, then a protective cover of at least 24 inches should be placed over the granular backfill to reduce the chance of surface run-off infiltration into the backfill materials. The protective cover should consist of relatively impervious, compacted soils. This cover should be moisture conditioned within 2 percentage points of the optimum moisture content. The on-site soils should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. The on-site soils should be placed in loose lifts of 8 inches with compacted thickness not exceeding 6 inches. Concrete flatwork constructed over the granular backfill can be considered for use as a protective cover in lieu of the compacted on-site soils.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 20 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

FLOOR SLABS

Information regarding existing and final grade elevation was not provided. We anticipate that finished floor elevation (FFE) may be at about 1½ feet above the existing grade. If significant fill or cuts are planned, Terracon should be notified to review and/or modify our recommendations given in this subsection.

The subsurface soils at this site generally exhibit high expansion potential. Based on the information developed from our field and laboratory programs and on method TEX-124-E in the Texas Department of Transportation (TxDOT) Manual of Testing Procedures, we estimate that the subgrade soils at this site exhibit a Potential Vertical Rise (PVR) of about 2½ inches in present condition.

The actual movements could be greater if poor drainage, ponded water, and/or other sources of moisture are allowed to infiltrate beneath the structure after construction. We have provided recommendations to reduce the site PVR to about 1 inch. In addition, positive structure perimeter drainage should be carefully observed.

After site stripping and over-excavation activities as recommended, place the select fill over a moisture conditioned and compacted fill body. The building pad should be constructed directly below the floor slab and should also extend a minimum of 3 feet beyond the edge of the proposed structure area, including any movement sensitive flatwork that abuts the structure such as sidewalks. The final exterior grade adjacent to the structure should be sloped to promote positive drainage away from the structure.

The subgrade and select fill soils should be prepared as outlined in the **Earthwork** section of this report, which contains material and placement requirements for select fill, as well as other subgrade preparation recommendations. The floor slab should be designed using the following recommendations.

Floor Slab Design Parameters

| Item | Description |
|---|--|
| Excavation | Minimum 24 inches. |
| Floor Slab Support ¹ | Minimum 6 inches of moisture conditioned and compacted native soils plus 3½ feet of select fill as needed to achieve Finished Building Pad Elevation (FBPE). This recommendation applies to building area and flatwork that abuts the structure such as sidewalks. |
| Estimated Modulus of Subgrade Reaction ² | 120 pounds per square inch per inch (psi/in) for point loads. |
| Estimated Potential Vertical Rise (PVR) | About 1 inch |

1. Floor slabs should be structurally independent of structure footings or walls (if any) to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

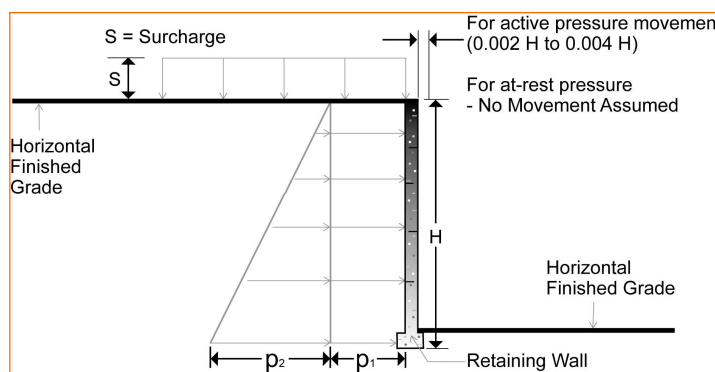
Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



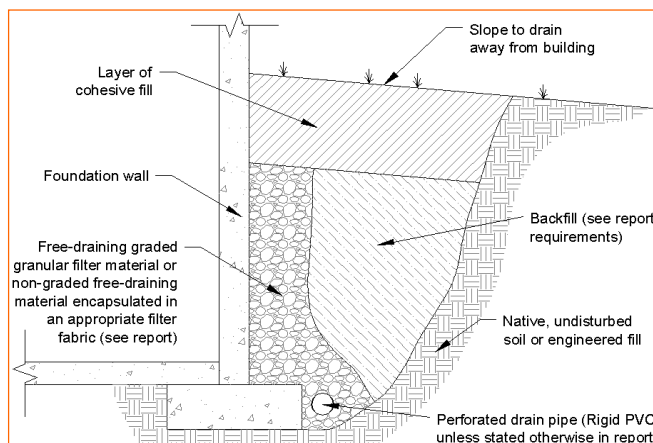
| Lateral Earth Pressure Design Parameters | | | | |
|--|-------------------------------|---|---|------------------------|
| Earth Pressure Condition ¹ | Coefficient for Backfill Type | Surcharge Pressure ^{2, 3, 4} p ₁ (psf) | Effective Fluid Pressures (psf) ^{4, 5} | |
| | | | Unsaturated ⁶ | Submerged ⁶ |
| Active (K _a) | Granular - 0.27 | (0.27)S | (35)H | (81)H |
| | Select Fill - 0.39 | (0.39)S | (47)H | (85)H |
| At-Rest (K _o) | Granular - 0.43 | (0.43)S | (55)H | (91)H |
| | Select Fill - 0.56 | (0.56)S | (67)H | (95)H |
| Passive (K _p) | Granular - 3.69 | --- | (480)H | (312)H |
| | Select Fill - 2.56 | --- | (307)H | (210)H |

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform surcharge, where S is surcharge pressure.
3. Loading from heavy compaction equipment is not included in surcharge or earth pressures.
4. No safety factor is included in these values.
5. Uniform, final graded backfill, compacted to at least 95 percent of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf.
6. In order to achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively. To calculate the resistance to sliding, a value of 0.40 should be used as the ultimate coefficient of friction between the footing and the underlying soil.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

PAVEMENTS

Both flexible and rigid pavements may be considered for this project. Pavement subgrade preparations are included in this section to limit changes in soil moisture conditions to help mitigate the effects of soil movement. However, even if these recommendations are followed some pavement distress could still occur.

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, must be applied to the site, which has been prepared as recommended in the **Site Preparation** section.

We recommend the moisture content and density of the top 6 inches of the subgrade be evaluated and the pavement subgrade be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and re-compacted.

Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Based on the subsurface conditions, we anticipate that the pavement subgrade will generally consist of the on-site soils. The top 6 inches of the finished subgrade soils directly beneath the pavements may be chemically treated. Chemical treatment will increase the supporting value of the subgrade and decrease the effect of moisture on subgrade soils. These 6 inches of treatment should be considered as required part of the pavement design and is not a part of site and subgrade preparation for wet/soft subgrade conditions.

If chemical treatment of the subgrade is chosen, we anticipate that the on-site surficial soils should be treated with about 5 percent of lime (modifier). This percentage is given as application by dry weight and is typically equivalent to about 25 pounds of modifier per square yard per 6-inch depth. The recommended percentage of modifier is for estimating and planning. The actual quantity of modifier required should be determined at the time of construction by laboratory tests on bulk samples of the subgrade soils. Specifications for treated subgrade are presented later in this section.

After proofrolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in **Earthwork** section of this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Pavement Design Considerations

Traffic patterns and anticipated loading conditions were not available at the time this report was prepared. However, we anticipate that traffic loads will be produced primarily by light traffic, delivery and trash removal trucks. Pavement thickness can be determined using AASHTO, Asphalt Institute and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided.

Terracon can provide thickness recommendations for pavements subjected to loads other than the above-mentioned traffic if this information is provided.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to parking lots and drives should slope down from pavement edges at a minimum 2%;
- The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote proper surface drainage;

Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144



- Install pavement drainage surrounding areas anticipated for frequent wetting (e.g., garden centers, wash racks);
- Install joint sealant and seal cracks immediately;
- Seal all landscaped areas in, or adjacent to pavements to reduce moisture migration to subgrade soils;
- Place compacted, low permeability backfill against the exterior side of curb and gutter; and,
- Place curb, gutter and/or sidewalk directly on low permeability subgrade soils rather than on unbound granular base course materials.

Estimated Minimum Pavement Thickness

As a minimum, we recommend the following typical pavement sections be considered.

| Pavement Area | Traffic Design Index | Description |
|-----------------------------------|----------------------|--|
| Automobile Parking Areas | DI-1 | Light traffic (Few vehicles heavier than passenger cars, no regular use by heavily loaded two axle trucks). (EAL ⁽¹⁾ < 6) |
| Driveways | DI-2 | Light to medium traffic (Similar to DI-1 including not over 50 loaded two axle trucks or lightly loaded larger vehicles per day. No regular use by heavily loaded trucks with three or more axles). (EAL = 6-20) |
| Driveways for Truck Traffic Areas | DI-3 | Medium to heavy traffic (Including not over 300 heavily loaded two axle trucks plus lightly loaded trucks with three or more axles and no more than 30 heavily loaded trucks with more than three axles per day). (EAL = 21-75) |

1. Equivalent daily 18-kip single-axle load applications.

Listed below are pavement component thicknesses, which may be used as a guide for pavement systems at the site for the traffic classifications stated herein. These systems were derived based on general characterization of the subgrade. Specific testing (such as CBR's, resilient modulus tests, etc.) was not performed for this project to evaluate the support characteristics of the subgrade.

| Minimum Recommended <u>Flexible</u> Pavement Section Thickness, inches | | |
|--|-------------------|-------------------|
| Component | DI-1 ¹ | DI-2 ¹ |
| Hot Mix Asphaltic Concrete (HMAC) ^{2, 3} | 2 | 2½ |
| Granular Base Material ² | 6 | 8 |
| Treated Subgrade ² | 6 | 6 |

1. See **Pavements** for more specifics regarding traffic information.
2. All materials should meet the current Department of Transportation (TxDOT) Standard Specifications for Highway and Bridge Construction.
3. A minimum 2-inch surface course should be used on Asphaltic Cement Concrete (ACC) pavements.

| Minimum Recommended <u>Rigid</u> Pavement Section Thickness, inches | | | |
|---|-------------------|-------------------|----------------------|
| Component | DI-1 ¹ | DI-2 ¹ | DI-3 ^{1, 3} |
| Reinforced PC Concrete ² | 5 | 6 | 7 |
| Granular Base Material ³ | 4 | 4 | 4 |
| Moisture Conditioned Subgrade | 6 | 6 | 6 |

1. See **Pavements** for more specifics regarding traffic information.
2. All materials should meet the current Department of Transportation (TxDOT) Standard Specifications for Highway and Bridge Construction. Concrete Pavement - TxDOT Portland Cement Concrete Class P or applicable ACI standards.
3. In areas of anticipated heavy traffic or concentrated loads (e.g. dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles. Six (6) inches of treated subgrade may be used instead of 4 inches of granular base material.

The listed pavement component thicknesses should be used as a guide for pavement systems at the site for the traffic classifications stated herein. These recommendations assume a 20-year pavement design life. If pavement frequencies or loads will be different than that specified Terracon should be contacted and allowed to review these pavement sections.

We recommend a Portland Cement Concrete (PCC) pavement be utilized in the main access lanes, parking lots, dumpster pads or other areas where extensive wheel maneuvering are expected.

We recommend that waste dumpster areas be constructed of at least 7 inches of reinforced concrete pavement. The concrete pad areas should be designed so that the vehicle wheels of the collection truck are supported on the concrete while the dumpster is being lifted to support the large wheel loading imposed during waste collection.

Although not required for structural support of rigid pavement systems, a base course layer may be considered to help reduce potentials for slab curl, shrinkage cracking, and subgrade “pumping” through joints.

Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Presented below are our recommended material requirements for the various pavement sections.

Reinforced Concrete Pavement: The materials and properties of reinforced concrete pavement shall meet applicable requirements in the ACI Manual of Concrete Practice. The Portland cement concrete mix should have a minimum 28-day compressive strength of 4,000 psi.

Reinforcing Steel: Reinforcing steel should consist of the following:

DI-1: #3 bars spaced at 18 inches or #4 bars spaced at 24 inches on centers in both directions.

DI-2: #3 bars spaced at 12 inches or #4 bars spaced at 18 inches on centers in both directions.

DI-3: #4 bars spaced at 12 inches on centers in both directions.

Control Joint Spacing: ACI recommendations indicate that control joints should be spaced at about 30 times the thickness of the pavement. Furthermore, ACI recommends a maximum control joint spacing of 12.5 feet for 5-inch pavements and a maximum control joint spacing of 15 feet for 6-inch or thicker pavements. Saw cut control joints should be cut within 6 to 12 hours of concrete placement or as soon as it is practical.

Expansion Joint Spacing: ACI recommendations indicate that regularly spaced expansion joints may be deleted from concrete pavements. Therefore, the installation of expansion joints is optional and should be evaluated by the design team.

Dowels at Expansion Joints: The dowels at expansion joints should be spaced at 12-inch centers and consist of the following:

DI-1: 5/8-inch diameter, 12-inches long with 5-inch embedment

DI-2: 3/4-inch diameter, 14-inches long with 6-inch embedment

DI-3: 7/8-inch diameter, 14-inches long with 6-inch embedment

Hot Mix Asphaltic Concrete Surface Course: The asphaltic concrete surface course should be plant mixed, hot laid Type C or D (Fine Graded Surface Course) meeting the specifications

requirements in 2014 TxDOT Standard Specifications Item 340. Specific criteria for the job specifications should include compaction to within an air void range of 5 to 9 percent calculated using the maximum theoretical gravity mix measured by TxDOT Tex-227-F. The asphalt cement content by percent of total mixture weight should be within ± 0.5 percent asphalt cement from the job mix design.

Granular Base Material: Granular base material should be composed of crushed limestone or crushed concrete meeting the requirements of 2014 TxDOT Standard Specifications Item 247, Type A or D, Grades 1-2 and/or 3.

As an alternate to the Type A base, treated “caliche” material meeting the requirements of 2014 TxDOT Standard Specification Manual Item 247, Type B, Grades 1-2 and/or 3 may be used.

The granular base should be compacted to at least 95 percent of the maximum dry density determined in accordance with the modified moisture-density relationship (ASTM D 1557) at moisture content within 2 percentage points of the optimum moisture content.

Treated Subgrade: The subgrade soils should be treated with lime in accordance with 2014 TxDOT Standard Specifications Item 260. The recommended percentage of modifier is for estimating and planning. The actual quantity of modifier required should be determined at the time of construction by laboratory tests on bulk samples of the subgrade soils.

If chemical treatment of the subgrade is chosen, we anticipate that the on-site surficial soils be treated with about 5 percent of lime (modifier). This percentage is given as application by dry weight and is typically equivalent to about 25 pounds of modifier per square yard per 6-inch depth. The subgrade should be compacted to a minimum of 95 percent of the Standard Effort (ASTM D 698) maximum dry density within 2 percentage points of the optimum moisture content. Preferably, traffic, should be kept off the treated subgrade for about 3 to 5 days to facilitate curing of the soil - chemical mixture; in addition, the subgrade is not suitable for heavy construction traffic prior to paving.

Post-construction subgrade movements and some cracking of the pavements are not uncommon for subgrade conditions such as those observed at this site. Although chemical treatment of the subgrade will help to reduce such movement/cracking, this movement/cracking cannot be economically eliminated.

Moisture Conditioned Subgrade: The subgrade should be scarified to a depth of 8 inches and moisture conditioned within 2 percentage points of the optimum moisture content. The subgrade should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 698. This should result in a compacted, moisture conditioned layer about 6 inches thick.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program.

Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

FROST CONSIDERATIONS

The soils on this site are not frost susceptible. However, amounts of water can affect the performance of the floor slabs and sidewalks. If frost action needs to be eliminated, we recommend the use of Non-Frost Susceptible (NFS) fill. Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave, if this occurs:

- Provide surface drainage away from the building and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs and pavements, and connect them to the storm drainage system.
- Grade clayey subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs and pavements critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.
- Place NFS materials in critical sidewalk areas.

As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

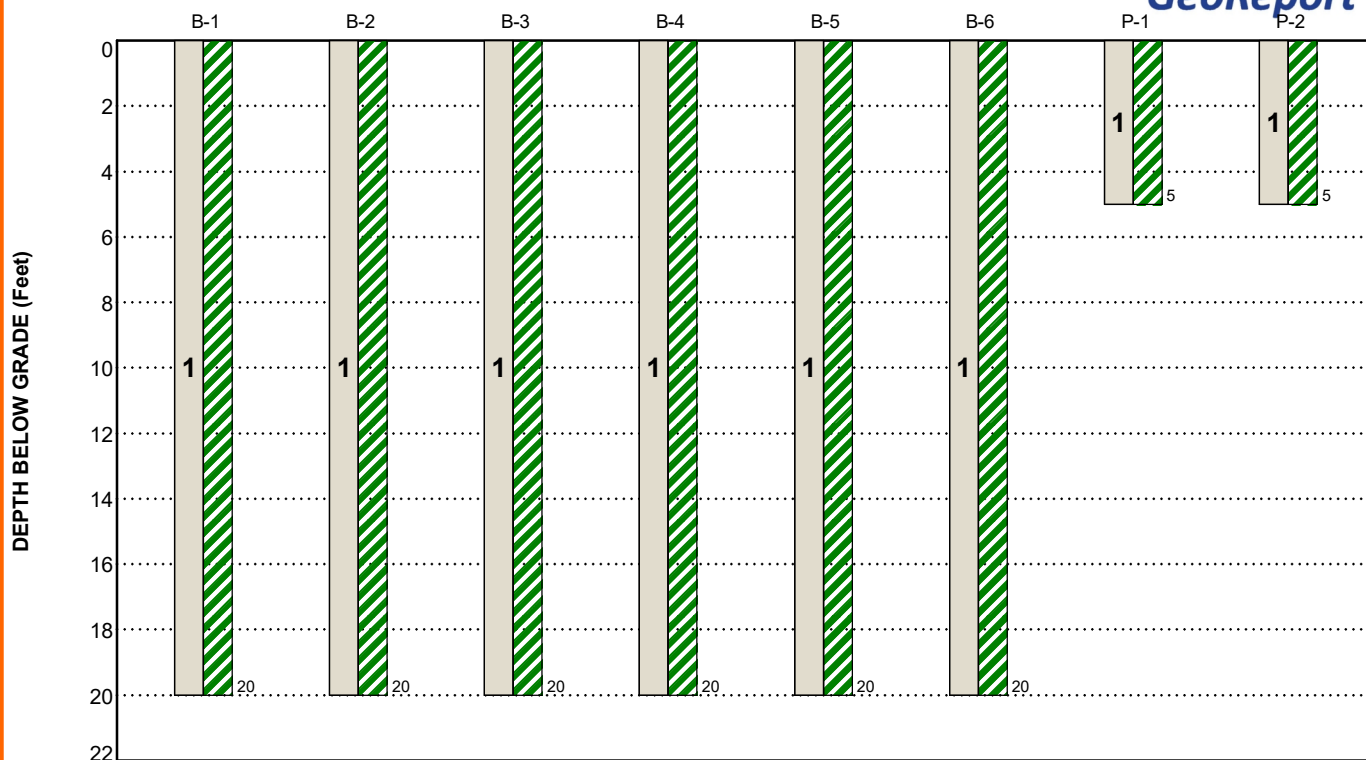
FIGURES

Contents:

GeoModel

GEOMODEL

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas
1/10/2019 ■ Terracon Project No. 88185144



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

| Model Layer | Layer Name | General Description |
|-------------|------------|--------------------------------|
| 1 | Fat Clay | Fat Clay, medium stiff to hard |

LEGEND



Fat Clay

- ▽ First Water Observation
- ▽ Second Water Observation
- ▽ Final Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

| Number of Borings | Boring Depth (feet) ¹ | Planned Location |
|-------------------|----------------------------------|---------------------------|
| 2 | 20 | Outdoor 25 yd x 25 m Pool |
| 1 | 20 | Diving Pool |
| 1 | 20 | Instructional Pool |
| 2 | 20 | Building Areas |
| 2 | 5 | Pavements |

¹. Below ground surface.

The drilling depths were based on topographic conditions at the time of our drilling operations.

Boring Layout and Elevations: Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ± 10 feet).

Subsurface Exploration Procedures: We advanced the soil borings with a truck-mounted drill rig using continuous flight augers (solid stem and/or hollow stem as necessary depending on soil conditions). Five samples were obtained in the upper 10 feet of the borings and at intervals of 5 feet thereafter. Soil sampling was performed using thin-wall tube and/or split-barrel sampling procedures. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, the borings were backfilled with auger cuttings after their completion.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a geotechnical engineer. Our exploration team prepared field boring logs as part of the drilling operations. The field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field log. The final boring logs represent the geotechnical engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned various laboratory tests to better understand the engineering properties of the various soil strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards

Geotechnical Engineering Report

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144



noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan

Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas
January 10, 2019 ■ Terracon Project No. 88185144

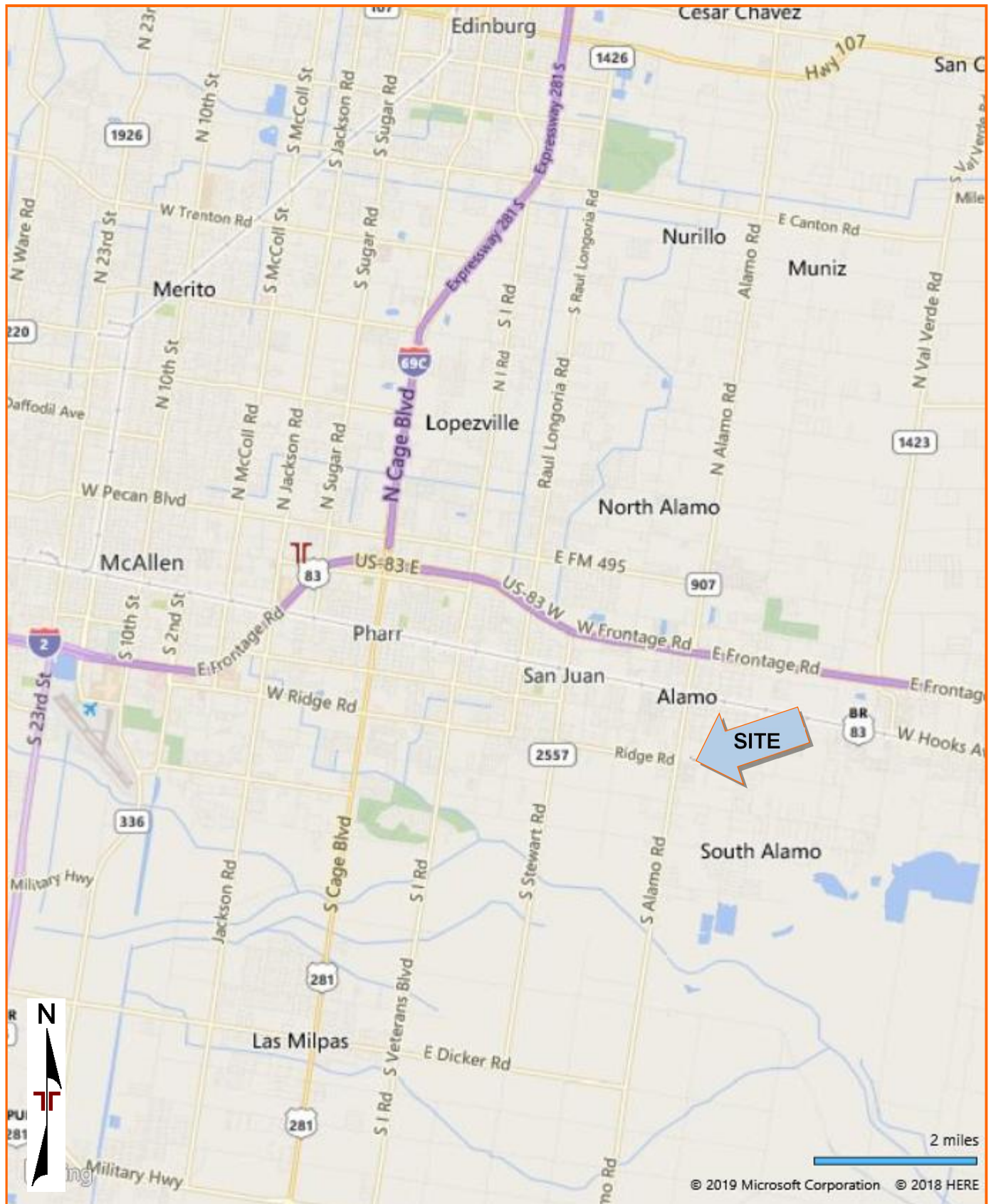


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS
NOT INTENDED FOR CONSTRUCTION PURPOSES

EXPLORATION PLAN

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas
January 10, 2019 ■ Terracon Project No. 88185144



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS
NOT INTENDED FOR CONSTRUCTION PURPOSES

EXPLORATION RESULTS

Contents:

Boring Logs

Swell Test Results

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.172286° Longitude: -98.122071° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|---|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | FAT CLAY (CH) , light brown, very stiff to hard - with sand seams at 4 feet - yellowish brown below 6 feet | 5 | | | 4.5+ (HP) | | | | 19 | | 55-17-38 | |
| | | | | | | 4.5+ (HP) | | | | 11 | | | |
| | | | | | | 3.5 (HP) | | 2.96 | 5 | 19 | 108 | | 79 |
| | | | | | | 3.0 (HP) | | | | 18 | | 61-21-40 | |
| | | | | | | 4.5+ (HP) | | 3.20 | 10.8 | 17 | 113 | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | 5-8-12 N=20 | | | | 10 | | 68-23-45 | |
| | | | | | | | | | | | | | |
| | | | | | | 7-12-12 N=24 | | | | 31 | | | |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-27-2018

Drill Rig: CME 55

Project No.: 88185144

Boring Completed: 12-27-2018

Driller: SWD


BORING LOG NO. B-2

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.172449° Longitude: -98.121574° DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS | PERCENT FINES |
|-------------|--|--|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | LL-PL-PI | |
| 1 |  | FAT CLAY (CH) , light brown, stiff to very stiff < | | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 20 feet.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Supporting Information](#) for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-27-2018

Boring Completed: 12-27-2018

Drill Rig: CME 55

Driller: SWD

Project No.: 88185144

Page 1 of 1

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

Hammer Type: Automatic.

Project No.: 88185144

BORING LOG NO. B-4

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.1725° Longitude: -98.121967° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|---|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | FAT CLAY (CH) , light brown, very stiff, with sand seams to 4 feet - yellowish brown below 2 feet | 5 | | | 3.25 (HP) | | | | 20 | | 57-21-36 | |
| | | | | | | 4.5+ (HP) | | | | 15 | | | 82 |
| | | | | | | 4.25 (HP) | | 5.46 | 7.1 | 15 | 117 | 56-17-39 | |
| | | | | | | 4.5+ (HP) | | | | 15 | | | |
| | | | | | | 4.5+ (HP) | | 5.08 | 9.3 | 17 | 114 | | |
| | | | | | | | | | | | | | |
| | | | | | | 6-9-12 N=21 | | | | 17 | | 55-20-35 | |
| | | | | | | | | | | | | | |
| | | | | | | 7-10-15 N=25 | | | | 20 | | | |
| | | | | | | | | | | | | | |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-27-2018

Drill Rig: CME 55

Project No.: 88185144

Boring Completed: 12-27-2018

Driller: SWD


BORING LOG NO. B-5

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.172419° Longitude: -98.121886° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|--|--|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 |  | FAT CLAY (CH) , light brown, stiff to hard - yellowish brown below 2½ feet - with sand seams at 4½ feet | 5 | | | 3-5-6 N=11 | | | | 20 | | 53-17-36 | 80 |
| | | | | | | 7-13-17 N=30 | | | | 11 | | | |
| | | | | | | 7-11-14 N=25 | | | | 14 | | | |
| | | | | | | 6-8-12 N=20 | | | | 16 | | | |
| | | | | | | 5-8-11 N=19 | | | | 17 | | | |
| | | | | | | 7-11-14 N=25 | | | | 17 | | | |
| | | | | | | 7-8-12 N=20 | | | | 17 | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-27-2018

Drill Rig: CME 55

Project No.: 88185144

Boring Completed: 12-27-2018

Driller: SWD

BORING LOG NO. B-6

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.172626° Longitude: -98.122056° | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|-------------|-------------|--|-------------|--------------------------|-------------|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | | |
| 1 | | FAT CLAY (CH) , light brown, stiff to very stiff - yellowish brown below 2½ feet | 5 | | | 2-5-5 N=10 | | | | 20 | | 54-20-34 | 84 |
| | | | | | | | | | | | | | |
| | | | | | | 5-7-10 N=17 | | | | 14 | | | |
| | | | | | | | | | | | | | |
| | | | | | | 6-11-14 N=25 | | | | 13 | | 56-17-39 | |
| | | | | | | | | | | | | | |
| | | | | | | 6-10-12 N=22 | | | | 15 | | | |
| | | | | | | | | | | | | | |
| | | | | | | 7-10-14 N=24 | | | | 15 | | 69-20-49 | |
| | | | | | | | | | | | | | |
| | | | 10 | | | | | | | | | | |
| | | | 15 | | | 6-9-12 N=21 | | | | 15 | | | |
| | | | | | | | | | | | | | |
| | | | 20 | | | 4-7-9 N=16 | | | | 19 | | 78-25-53 | |
| | | Boring Terminated at 20 Feet | 20 | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 20 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-27-2018

Drill Rig: CME 55

Project No.: 88185144

Boring Completed: 12-27-2018

Driller: SWD



BORING LOG NO. P-1

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.17296° Longitude: -98.12178° DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS | PERCENT FINES |
|-------------|---|---|-------------|--------------------------|---|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | LL-PL-PI | |
| 1 |  | FAT CLAY (CH) , light brown, medium stiff to very stiff - yellowish brown at 3½ feet | 5 | |  | 3-3-4 N=7 | | | | 21 | | 54-19-35 | |
| | | | | | | 5-11-14 N=25 | | | | 12 | | | 83 |
| | | Boring Terminated at 5 Feet | | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 5 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Started: 12-27-2018

Drill Rig: CME 55

Project No.: 88185144

Boring Completed: 12-27-2018

Driller: SWD



BORING LOG NO. P-2

Page 1 of 1

PROJECT: PSJA Memorial Early College HS - Outdoor Pool

CLIENT: Pharr-San-Juan-Alamo ISD
San Juan, Texas

SITE: 800 S. Alamo Road
Alamo, Texas

| MODEL LAYER | GRAPHIC LOG | LOCATION See Exploration Plan Latitude: 26.17293° Longitude: -98.12213° DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | STRENGTH TEST | | | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS | PERCENT FINES |
|-------------|---|---|-------------|--------------------------|---|--------------------|---------------|----------------------------|------------|-------------------|-----------------------|------------------|---------------|
| | | | | | | | TEST TYPE | COMPRESSIVE STRENGTH (tsf) | STRAIN (%) | | | LL-PL-PI | |
| 1 |  | FAT CLAY (CH) , light brown, medium stiff to stiff - yellowish brown at 3½ feet | 5 | |  | 2-2-3 N=5 | | | | 18 | | | 85 |
| | | | | | | | | | | | | | |
| | | | | | | 4-5-8 N=13 | | | | 16 | | 50-18-32 | |
| | | Boring Terminated at 5 Feet | | | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic.

Advancement Method:
Dry Augered from 0 to 5 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).

See [Supporting Information](#) for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater was not observed.



Boring Started: 12-27-2018

Drill Rig: CME 55

Project No.: 88185144

Boring Completed: 12-27-2018

Driller: SWD

PSJA Memorial Early College - Outdoor Pool
800 S. Alamo Road
Alamo, Texas

Project No.: 88185144

SWELL TEST SUMMARY

| Boring No. | Depth (feet) | Overburden Pressure (psf) | INITIAL CONDITIONS | | FINAL CONDITIONS | | Moisture Gain (%) | Percent Swell |
|---------------|-----------------|---------------------------------|----------------------------|---------------------|----------------------------|---------------------|-------------------------|------------------|
| | | | Moisture Content (%) | γ_d (pcf) | Moisture Content (%) | γ_d (pcf) | | |
| B-1 | 3.0 | 100 | 10.4 | 118.1 | 18.7 | 93.0 | 8.2 | 7.00 |
| B-1 | 7.0 | 100 | 17.1 | 110.7 | 20.2 | 90.4 | 3.1 | 1.90 |
| B-4 | 3.0 | 100 | 13.7 | 115.2 | 18.5 | 93.9 | 4.8 | 3.50 |
| B-4 | 7.0 | 100 | 15.3 | 114.1 | 21.1 | 88.1 | 5.8 | 7.00 |

PSJA Memorial Early College - Outdoor Pool
800 S. Alamo Road
Alamo, Texas

Project No.: 88185144

SWELL TEST SUMMARY

| Boring No. | Depth (feet) | Overburden Pressure (psf) | INITIAL CONDITIONS | | FINAL CONDITIONS | | Moisture Gain (%) | Percent Swell |
|---------------|-----------------|---------------------------------|----------------------------|----------------|----------------------------|----------------|-------------------------|------------------|
| | | | Moisture Content (%) | q_u (pcf) | Moisture Content (%) | q_u (pcf) | | |
| B-1 | 3.0 | 460 | 10.4 | 118.1 | 18.7 | 94.5 | 8.2 | 5.30 |
| B-1 | 7.0 | 940 | 15.9 | 111.7 | 18.4 | 93.8 | 2.5 | 0.60 |
| B-4 | 3.0 | 460 | 14.1 | 116.2 | 17.8 | 97.6 | 3.6 | 1.10 |
| B-4 | 7.0 | 940 | 14.8 | 114.1 | 18.5 | 94.5 | 3.7 | 1.90 |

SUPPORTING INFORMATION

Contents:

General Notes

Unified Soil Classification System






Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

PSJA Memorial Early College HS - Outdoor Pool ■ Alamo, Texas

January 10, 2019 ■ Terracon Project No. 88185144

| SAMPLING | WATER LEVEL | FIELD TESTS |
|---|---|---|
|  Shelby Tube  Split Spoon |  Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time <p>Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.</p> | (N) Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer (UC) Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer |

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

| RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance | | CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance | | |
|---|---|---|---|---|
| Descriptive Term (Density) | Standard Penetration or N-Value Blows/Ft. | Descriptive Term (Consistency) | Unconfined Compressive Strength Qu, (tsf) | Standard Penetration or N-Value Blows/Ft. |
| Very Loose | 0 - 3 | Very Soft | less than 0.25 | 0 - 1 |
| Loose | 4 - 9 | Soft | 0.25 to 0.50 | 2 - 4 |
| Medium Dense | 10 - 29 | Medium Stiff | 0.50 to 1.00 | 4 - 8 |
| Dense | 30 - 50 | Stiff | 1.00 to 2.00 | 8 - 15 |
| Very Dense | > 50 | Very Stiff | 2.00 to 4.00 | 15 - 30 |
| | | Hard | > 4.00 | > 30 |

| RELATIVE PROPORTIONS OF SAND AND GRAVEL | | RELATIVE PROPORTIONS OF FINES | |
|---|--------------------------------------|---|-----------------------|
| Descriptive Term(s) of other constituents | Percent of Dry Weight | Descriptive Term(s) of other constituents | Percent of Dry Weight |
| Trace | <15 | Trace | <5 |
| With | 15-29 | With | 5-12 |
| Modifier | >30 | Modifier | >12 |
| GRAIN SIZE TERMINOLOGY | | PLASTICITY DESCRIPTION | |
| Major Component of Sample | Particle Size | Term | Plasticity Index |
| Boulders | Over 12 in. (300 mm) | Non-plastic | 0 |
| Cobbles | 12 in. to 3 in. (300mm to 75mm) | Low | 1 - 10 |
| Gravel | 3 in. to #4 sieve (75mm to 4.75 mm) | Medium | 11 - 30 |
| Sand | #4 to #200 sieve (4.75mm to 0.075mm) | High | > 30 |
| Silt or Clay | Passing #200 sieve (0.075mm) | | |

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A | | | | | Soil Classification | |
|--|--|---|---|--------|------------------------------------|------------------------------------|
| | | | | | Group Symbol | Group Name ^B |
| Coarse-Grained Soils: More than 50% retained on No. 200 sieve | Gravels: More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels: Less than 5% fines ^C | Cu ³ 4 and 1 £ Cc £ 3 ^E | GW | Well-graded gravel ^F | |
| | | | Cu < 4 and/or [Cc<1 or Cc>3.0] ^E | GP | Poorly graded gravel ^F | |
| | | Gravels with Fines: More than 12% fines ^C | Fines classify as ML or MH | GM | Silty gravel ^{F, G, H} | |
| | | | Fines classify as CL or CH | GC | Clayey gravel ^{F, G, H} | |
| | Sands: 50% or more of coarse fraction passes No. 4 sieve | Clean Sands: Less than 5% fines ^D | Cu ³ 6 and 1 £ Cc £ 3 ^E | SW | Well-graded sand ^I | |
| | | | Cu < 6 and/or [Cc<1 or Cc>3.0] ^E | SP | Poorly graded sand ^I | |
| | | Sands with Fines: More than 12% fines ^D | Fines classify as ML or MH | SM | Silty sand ^{G, H, I} | |
| | | | Fines classify as CL or CH | SC | Clayey sand ^{G, H, I} | |
| Fine-Grained Soils: 50% or more passes the No. 200 sieve | Silts and Clays: Liquid limit less than 50 | Inorganic: | PI > 7 and plots on or above “A” | CL | Lean clay ^{K, L, M} | |
| | | | PI < 4 or plots below “A” line ^J | ML | Silt ^{K, L, M} | |
| | | Organic: | Liquid limit - oven dried | < 0.75 | OL | Organic clay ^{K, L, M, N} |
| | | | Liquid limit - not dried | | Organic silt ^{K, L, M, O} | |
| | Silts and Clays: Liquid limit 50 or more | Inorganic: | PI plots on or above “A” line | CH | Fat clay ^{K, L, M} | |
| | | | PI plots below “A” line | MH | Elastic Silt ^{K, L, M} | |
| | | Organic: | Liquid limit - oven dried | < 0.75 | OH | Organic clay ^{K, L, M, P} |
| | | | Liquid limit - not dried | | Organic silt ^{K, L, M, Q} | |
| Highly organic soils: | Primarily organic matter, dark in color, and organic odor | | | PT | Peat | |

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

$$E \text{ Cu} = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains ³ 15% sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains ³ 15% gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

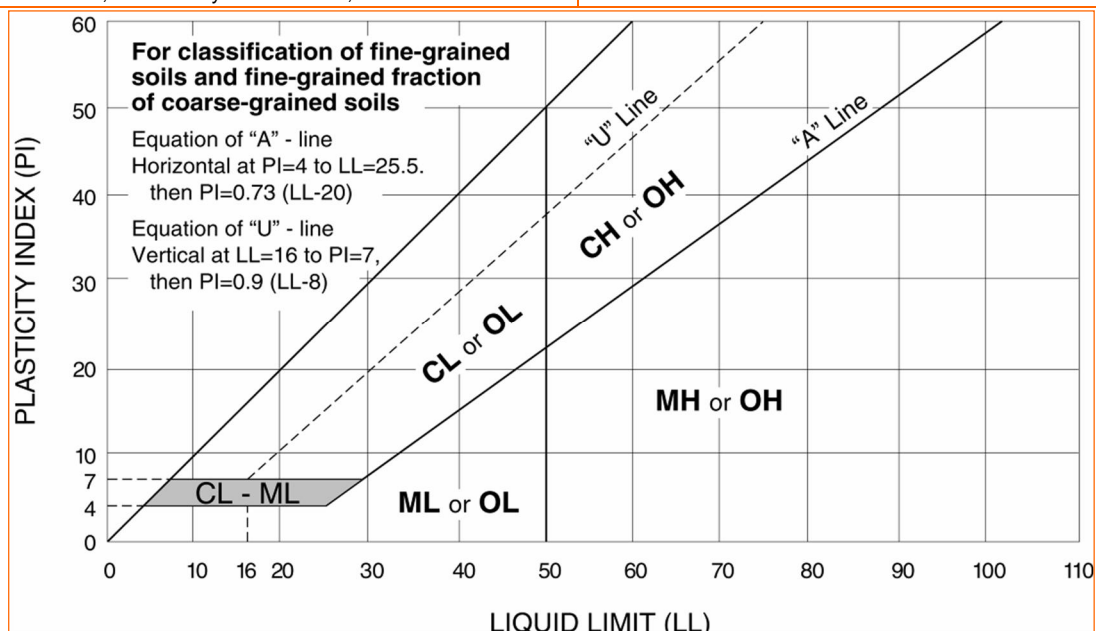
^M If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

^N PI ³ 4 and plots on or above "A" line.

^O PI < 4 or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



SECTION 00 11 00 - REQUEST FOR COMPETITIVE SEALED PROPOSALS

The Pharr – San Juan – Alamo I.S.D. will receive bids electronically for **PSJA ISD NEW SWIMMING FACILITIES
BID # 18-19-039 UNTIL 4:00 P.M. ON THURSDAY MAY 16, 2019**

ESTIMATED CONSTRUCTION COST: **\$8,500,000**

A CERTIFIED CHECK OR BANK DRAFT, payable to the Pharr – San Juan – Alamo I.S.D., negotiable U.S. Government Bonds (at par value) or a satisfactory Bid Bond executed by the bidder and an acceptable surety in an amount equal to five percent (5%) of the total bid shall be submitted with each bid.

STATUTORY BOND for performance of the Contract and for payments of materials will be required in an amount equal to 100% of the accepted bid, if the bid exceeds \$25,000 and MUST BE LICENSED TO DO BUSINESS IN THE STATE OF TEXAS.

ATTENTION IS CALLED to the fact that not less than the minimum prevailing salaries and wages as set forth in the DAVIS– BACON ACT must be paid on this project, and that contractor must ensure that employees and applicants for employment are not discriminated against because of their race, color, religion, sex or national origin.

PRE–BID CONFERENCE: There will be a “Pre–Bid Conference” conducted at the PSJA Administration Building Finance Department – Conference Room #205, located at 601 E. Kelly, Pharr, Texas 78577, on **Thursday May 2nd, 2019 at 10:00 p.m.**

JOB SITE VISIT: There will be a site visit on **Thursday May 2, 2019 following Pre-bid Conference at PSJA ECHS at 805 W. Ridge Road, San Juan, Tx. 78589 and PSJA Memorial ECHS at 800 S. Alamo Road, Alamo, Tx. 78516**

BID MAY BE held by the Pharr – San Juan – Alamo I.S.D. for a period not to exceed sixty (60) days from the date of the opening bid/proposal for the purpose of reviewing the bid and investigating the qualifications of bidder, prior to awarding of the contract.

The bid will be available online on the Pharr-San Juan-Alamo I.S.D. website (www.psjaisd.us). Please place your cursor over the “About Us” tab and select “Departments”, from the Purchasing Department field select “View Website”. Select “PSJA ELECTRONIC BID SYSTEM” from the menu list on the left to access the District’s Purchasing Website to view available bids and proposals. Electronic bids will be received until, **4:00P.M. ON THURSDAY, May 16th, 2019** at which time they will be publicly opened.

ALL questions regarding this Bid must be submitted through the **PSJA ELECTRONIC BID SYSTEM** or in written format to Emily Garza emily.garza@psjaisd.us at P.O. Box 769, 601 East Kelly, Pharr, Texas, 78577 on or before **Monday, May 13th, 2019 @ 10:00 a.m.**

ADVERTISE DATES: The Advance: Wednesday April 17th & April 24th 2019

The Monitor: Sunday April 21st & April 28th 2019

DOCUMENT 00 40 00 - COMPETITIVE SEALED PROPOSAL FORM

**PSJA NEW SWIMMING FACILITIES
PHARR-SAN JUAN- ALAMO INDEPENDENT SCHOOL DISTRICT**

Submitted by: _____

Date: _____ Phone No.: _____

To: Emily Garza, Director of Purchasing
Pharr-San Juan-Alamo
601 East Kelly Street
Pharr, Texas 78577

Having examined Proposal and Contract Documents prepared by PBK, Inc., dated **April 11, 2019** and having examined site conditions, the undersigned proposes to furnish all labor, equipment and materials and perform all work for the completion of the above-named project for the sum indicated below.

In submitting his Proposal, the undersigned agrees to the following:

1. Hold proposal open for acceptance 45 days.
2. Accept right of Owner to reject any or all proposals, to waive formalities and to accept proposal which Owner considers most advantageous.
3. Enter into and execute the contract, if awarded, for the Base Proposal and accepted Alternate Proposals.
4. Complete work in accordance with the Contract Documents within the stipulated contract time.
5. By signing, the undersigned affirms that, to the best of his knowledge, the Proposals have been arrived at independently and is submitted without collusion with anyone to obtain information or gain any favoritism that would in any way limit competition or give an unfair advantage over respondents in the award of this proposal.

I. BASE PROPOSAL

Undersigned agrees to complete the Work for the lump sum amount as follows:

Total PSJA High School and PSJA Memorial HS New Swimming Facilities (Including Allowances)

_____ Dollars \$ _____
(Amount written in words governs) (Amount in figures)

Time of completion: 300 consecutive calendar days upon issuance of Notice to Proceed.

NOTE: THIS DOCUMENT MUST BE SUBMITTED

II. ALTERNATES

A. Alternate No 01: Pre-Engineered Metal Canopy over Competition Pool.

Provide alternate pricing to furnish and install Pre-Engineering Metal Canopy as indicated at both PSJA High School and PSJA Memorial HS New Swimming Facilities. Include alternate lighting as indicated. Include masonry column wraps as indicated. Include underground drainage to each of the canopy downspouts as indicated. Exclude the Pre-Engineered Aluminum Canopy (Avadek-type) over the bleachers, associated drainage and wall canopies over all public doors and storefronts.

(Amount written in words governs) Dollars \$ _____
(Amount in figures)

B. Alternate No 02: Diving Pool.

Provide alternate pricing for the Diving Pool, surrounding trench drain, bleachers, associated Pool Equipment and MEP Systems as indicated in the plans and specifications at both PSJA High School and PSJA Memorial High School New Swimming Facilities.

(Amount written in words governs) Dollars \$ _____
(Amount in figures)

III. ALLOWANCES

Undersigned certifies that the specified allowances are included in the Base Proposal and agrees that any unexpended balance of allowance sums will revert to Owner in the final settlement of the contract.

Owner's Contingency Allowance included in the Base Proposal: **\$100,000.00**

MEPT Contingency Allowance included in the Base Proposal: **\$50,000.00**

Steel Contingency Allowance included in the Base Proposal: **\$35,000.00**

IV. ADDENDA

Undersigned acknowledges receipt of Addenda No. _____
dated _____, 2019.

Undersigned acknowledges receipt of Addenda No. _____
dated _____, 2019.

Undersigned acknowledges receipt of Addenda No. _____
dated _____, 2019.

Undersigned acknowledges receipt of Addenda No. _____
dated _____, 2019.

NOTE: THIS DOCUMENT MUST BE SUBMITTED

V. CHANGES IN THE WORK

Undersigned understands that changes in the work shall be performed in accordance with the Supplementary Conditions.

VI. LIQUIDATED DAMAGES

Undersigned understands that liquidated damages as defined in the Supplementary Conditions will be included in the form of Agreement between Owner and Contractor and that the contractor will be bound thereto.

It is understood that the right is reserved by the Owner to reject any or all proposals, or waive any informalities in the proposal process.

(Seal, if a Corporation)
State whether Corporation,
Partnership or Individual

Authorized Signature

Title

Name of Contracting Firm

Address

Telephone

Date

END OF DOCUMENT 00 40 00

NOTE: THIS DOCUMENT MUST BE SUBMITTED

DOCUMENT 00 40 11 - FELONY CONVICTION NOTIFICATION

Note: The Statement of Affirmation Must Be Notarized

STATEMENT OF AFFIRMATION

"The undersigned affirms that he/she is duly authorized to provide this information by the person(s) or business entity making the proposal, and the information provided below concerning felony convictions has been personally and thoroughly reviewed, and verified, and is, therefore, current, true and accurate to the best of my knowledge."

Firm's

Name: _____ Address: _____

"a. _____ My firm is a publicly held corporation, therefore, this reporting requirement is not applicable."

"b. _____ My firm is not owned nor operated by anyone who has been convicted of a felony."

"c. _____ My firm is owned or operated by the following individual(s) who has/have been convicted of a felony:"

Name of Felon(s)

Details of Conviction(s) _____

PLEASE CHECK a, b, or c ABOVE AND SIGN BELOW

Offeror's

Name _____ Position/Title _____

Offeror's

Signature _____ Date _____

Subscribed and sworn to me on this _____ day of _____

Notary Public

My Commission expires _____

END OF DOCUMENT 00 40 11

NOTE: THIS DOCUMENT MUST BE EXECUTED AND SUBMITTED WITH PROPOSAL

FELONY CONVICTION NOTIFICATION

00 40 11 - 1

LIST OF SUBCONTRACTORS
00 40 12 - 1

DOCUMENT 00 40 17 - CERTIFICATION OF CRIMINAL HISTORY RECORD INFORMATION

REVIEW BY CONTRACTOR-EMPLOYER

Certifying Affidavit submitted to:

Name of School District: _____

Mailing Address: _____

Project: _____

STATE OF TEXAS §

COUNTY OF §

(1) The undersigned representative, on behalf of the contracting firm identified below, swears and affirms to Lamar Consolidated Independent School District (the "District") that such firm has obtained, reviewed and verified, from a law enforcement or criminal justice agency or a private entity that is consumer reporting agency governed by the Fair Credit Reporting Act (15 U.S.C. §§ 1681 et seq.) the criminal history record information of all employees hired **before January 1, 2008**, who (a) have or will have continuing duties related to the contracted services, and (b) have or will have direct contact with students. Such employees are identified by name on Schedule **A** (contractor shall provide and attach hereto). The undersigned further swears and affirms no employees who meet the requirements of (a) and (b) herein and/or identified on Schedule **A** have been convicted of any offense identified in Section 22.085 of the Texas Education Code.

(2) The undersigned representative, on behalf of the contracting firm identified below, swears and affirms to the District, that such firm has obtained, reviewed and verified, from the Texas Department of Public Safety criminal clearinghouse, the national criminal history record information of all employees hired **on or after January 1, 2008**, who (a) have or will have continuing duties related to the contracted services, and (b) have or will have direct contact with students. Such employees are identified by name on Schedule B (contractor shall provide and attach hereto). The undersigned further swears and affirms no employees who meet the requirements of (a) and (b) herein and/or identified on Schedule B have been convicted of any offense identified in Section 22.085 of the Texas Education Code.

(3) The undersigned firm swears and covenants that no present or future employee will provide services to the Project that involve direct contact with students unless and until such employee's national criminal history record information has been reviewed and cleared as required by Paragraph (2) above, and an updated Certification has submitted by the contracting firm to the District with an updated Schedule B identifying such employees. In the event of an emergency, an employee who has not been previously certified may only provide services that involve direct contact with students if such employee is escorted by a District representative.

(4) The undersigned firm swears and covenants that, upon receipt of information, directly or indirectly, that any employee of the contracting firm has been convicted of an offense identified in Section 22.085 of the Texas Education Code, the contracting firm will immediately remove such employee from the Project and notify the District.

(5) Furthermore, if requested by the District, the name, driver's license number, and any other information required by the DPS will be submitted to the District for any person on either Schedule A or Schedule B.

_____, being duly sworn, affirms and certifies that he/she is the
_____ (position) of _____(contracting firm),
and that all statements and acknowledgements contained herein are true and correct, and that he/she
has the authority to bind such firm to the covenants set out above.

SUBSCRIBED AND SWORN TO BEFORE ME this _____ day of _____.

Notary Public _____ State of _____

My Commission expires _____

END OF DOCUMENT 00 40 17

DOCUMENT 00 40 18 - CONFLICT OF INTEREST QUESTIONNAIRE

INSTRUCTIONS

According to Local Government Code, Chapter 176, a person or an agent of a person who contracts or seeks to contract for the sale or purchase of property, goods, or services with Lamar Consolidated Independent School District must file a completed Conflict of Interest Questionnaire with the District Legal Department not later than the seventh business day after the date that the person begins contract discussions or negotiations with the District or submits to the District an application, response to a request for proposals or bids, correspondence, or another writing related to a potential agreement with the District.

This Conflict of Interest Questionnaire must be filed annually by September 1 as long as the person or the agent of the person continues to contract or seek to contract for the sale or purchase of property, goods, or services with the District or not later than the 7th business day after the date the originally filed questionnaire becomes incomplete or inaccurate.

The completion of the Conflict of Interest Questionnaire is not needed if the person is an employee of a governmental entity and is acting in the employee's official capacity.

Explanation of the Conflict of Interest Questionnaire

1. Name of person doing business with the District.
2. Check the box if you are filing an update to a previously filed questionnaire.
3. Describe each affiliation or business relationship with an employee or contractor of the District who makes recommendations to a District officer with respect to expenditure of money. **If no affiliation or business relationship exists, state "NONE."**

Examples:

If your spouse, parent, or child is the District's Director of Purchasing and a bid is being submitted to the Purchasing Department, this relationship must be reported.

If your spouse, parent, or child is the Principal at a School and your business may sell items directly to that school, this relationship must be reported.

If you or your spouse, parent, or child is in business with a District employee that would be making a recommendation concerning a purchase or sales transaction involving you, the relationship must be reported.

If you employ or do business with a spouse, parent, or child of a District employee that would be making a recommendation concerning a purchase or sales transaction involving you, the relationship must be reported.

If you are a District employee and would be making a recommendation concerning a purchase or sales transaction involving you, the relationship must be reported.

If your spouse, parent, or child is a teacher that does not make recommendations concerning purchasing or sales transactions, this relationship should **not** be reported.

If your spouse, parent, or child is a Principal at a School and a bid is being considered by a separate department such as Facilities Planning (Construction Department), this relationship should **not** be reported.

4. Describe each affiliation or business relationship with a person who is a District officer and who appoints or employs a District officer that is the subject of this questionnaire. **If no affiliation or business relationship exists, state "NONE."**

Example:

If you or your spouse, parent, or child is related to, employs, or is in business with a District officer or their spouse, parent, or child, this relationship must be reported.

5. Name of District officer with whom you have an affiliation or business relationship.

For each person listed under question #4, complete page 2. If answers to A, B, and C are NO, indicate the name of the District officer, but do not complete section D.

6. Describe any other affiliation or business relationship that might cause a conflict of interest.

Example:

If your neighbor or friend is a District employee that would be making a recommendation concerning a purchase or sales transaction involving you and you feel that your relationship with this employee could affect their recommendation, this relationship must be reported.

If any other situation exists that would result in a conflict of interest, the relationship must be reported.

7. Sign and date this form.

Submit the completed form to the District. If any disclosures are indicated under questions #3 or #4, the form will be posted on the District's website.

FILL CONFLICT OF INTEREST QUESTIONNAIRE ON NEXT PAGE

END OF DOCUMENT 00 40 18

| | |
|--|----------------------------------|
| CONFLICT OF INTEREST QUESTIONNAIRE For vendor or other person doing business with local governmental entity | FORM CIQ Page 2 |
| <div style="border: 1px solid black; padding: 5px;"><div style="display: flex; justify-content: space-between;"><div style="width: 5%; text-align: center;">5</div><div style="width: 95%;"><p>Name of local government officer with whom filer has affiliation or business relationship. (Complete this section only if the answer to A, B, or C is YES.)</p><p>This section, item 5 including subparts A, B, C & D, must be completed for each officer with whom the filer has affiliation or business relationship. Attach additional pages to this Form CIQ as necessary.</p><p>A. Is the local government officer named in this section receiving or likely to receive taxable income from the filer of the questionnaire?</p><div style="display: flex; justify-content: space-around; margin-top: 10px;"><div><input type="checkbox"/> Yes</div><div><input type="checkbox"/> No</div></div><p>B. Is the filer of the questionnaire receiving or likely to receive taxable income from or at the direction of the local government officer named in this section AND the taxable income is not from the local governmental entity?</p><div style="display: flex; justify-content: space-around; margin-top: 10px;"><div><input type="checkbox"/> Yes</div><div><input type="checkbox"/> No</div></div><p>C. Is the filer of this questionnaire affiliated with a corporation or other business entity that the local government officer serves as an officer or director, or holds an ownership of 10 percent or more?</p><div style="display: flex; justify-content: space-around; margin-top: 10px;"><div><input type="checkbox"/> Yes</div><div><input type="checkbox"/> No</div></div><p>D. Describe each affiliation or business relationship.</p></div></div></div> | |
| <div style="border: 1px solid black; padding: 5px;"><div style="display: flex; justify-content: space-between;"><div style="width: 5%; text-align: center;">6</div><div style="width: 95%;"><p>Describe any other affiliation or business relationship that might cause a conflict of interest.</p></div></div></div> | |
| <div style="border: 1px solid black; padding: 5px;"><div style="display: flex; justify-content: space-between;"><div style="width: 5%; text-align: center;">7</div><div style="width: 95%;"><div style="display: flex; justify-content: space-between; margin-top: 100px;"><div style="width: 60%;"><hr style="border: 0; border-top: 1px solid black; margin-bottom: 5px;"/><div style="text-align: center; font-size: small;">Signature of person doing business with the governmental entity</div></div><div style="width: 35%;"><hr style="border: 0; border-top: 1px solid black; margin-bottom: 5px;"/><div style="text-align: center; font-size: small;">Date</div></div></div></div></div></div> | |

DOCUMENT 00 45 00 - AFFIDAVIT OF NON-DISCRIMINATORY EMPLOYMENT

STATE OF TEXAS)
)
COUNTY OF _____)

AFFIDAVIT

This Company, Contractor, or Subcontractor agrees to refrain from discrimination in terms and conditions of employment to the basis of race, color, religion, sex, or national origin, and agrees to take affirmative action as required by Federal Statutes and rules and Regulations issued pursuant thereto in order to maintain and insure non-discriminatory employment practices.

Company

Printed Name

Signature

STATE OF TEXAS)
)
COUNTY OF _____)

Sworn to and subscribed before me at _____, Texas, this the _____ day of _____, 20__.

Notary Public in and for [] County, Texas

END OF DOCUMENT

NOTE: THIS DOCUMENT MUST BE EXECUTED AND SUBMITTED WITH PROPOSAL

DOCUMENT 00 50 00 - TEXAS STATUTORY PERFORMANCE BOND
(Penalty of this bond must be 100% of contract amount)

Bond No.: _____

KNOW ALL MEN BY THESE PRESENTS, that: _____
(hereinafter called the Principal), as principal, and _____
a corporation organized and existing under the laws of the State of _____
authorized and admitted to do business in the State of Texas and licensed by the State of Texas to
execute bonds as Surety (hereinafter called the Surety), as Surety, are held and firmly bound unto

(hereinafter called the Obligee) in the amount of _____

Dollars(\$ _____) for the payment whereof, the said Principal and Surety bind
themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally,
firmly by these presents.

WHEREAS, the Principal has entered into a certain written contract with the Obligee, dated the _____
day of _____, 20__, for

**PSJA ISD SWIMMING FACILITIES
PHARR-SAN JUAN-ALAMO INDEPENDENT SCHOOL DISTRICT**

which contract is hereby referred to and made a part hereof as fully and the same extent as if copied at
length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal
shall faithfully perform the work in accordance with the plans, specifications and contract documents, then
this obligation shall be void; otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Chapter 2253 of the
Texas Government Code and all liabilities on this bond shall be determined in accordance with the
provisions of said Chapter to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this Instrument this
_____ day of _____, 20__.

Principal (Seal)

Surety Address By: _____

Surety (Seal)

Surety Telephone Number By: _____
Attorney-in-Fact

END OF DOCUMENT 00 50 00

SECTION 00 63 00 - CIVIL ENGINEERING REQUESTS FOR INFORMATION

PART I- GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administrative and procedural requirements for handling and processing "Requests for Information" (RFI).
 - 2. "Request for Information" process diagram is attached at the end of this Section.
 - 3. "Request for Information" form is attached at the end of this Section.

1.2 DEFINITION

- A. Requests for Information: A formal process used during the construction phase to facilitate communication between the contractor and the Civil Engineering consultant with regard to requests for additional information and clarification of the intent of the Contract Documents (Drawings and Specifications).
- B. Do not use "Request for Information" form during bidding. Direct questions during bidding phase as indicated in the bid documents.

1.3 PROCEDURE

- A. Conditions Requiring Clarification of the Contract Documents:
 - 1. Contractor shall submit a "Request for Information" to the civil Engineering Consultant.
 - 2. Submit "Requests for Information" from Contractor's office or field office only. "Requests for Information" submitted directly from subcontractors or suppliers will not be accepted.
 - 3. Generate "Requests for Information" by one source per project and number accordingly.
 - 4. Submit one "Request for Information" per form.
- B. Civil Engineering Consultant will review RFI from the Contractor with reasonable promptness and the Contractor will be notified in writing of decisions made.
 - 1. The Civil Engineering Consultant's written response to the RFI shall not be considered as a Change Order or Change Directive, nor does it authorize changes in the Contract Sum or Contract Time.
- C. Contractor shall maintain a log of "Requests for Information" sent to, and responses from Civil Engineering Consultant. "Requests for Information" log shall be sent, by Fax, every Friday to the Civil Engineering Consultant.
- D. All "Requests for Information" regarding scheduling, costing and owner provided equipment coordination shall be directed to the owner's Construction Manager.

1.4 REQUEST FOR INFORMATION FORM

- A. Submit "Requests for Information" on the attached "Request for Information" form, or format accordingly on letterhead. Civil Engineering Consultant will not respond to requests for information unless this form or format is utilized.
- B. Where submittal form or format does not provide space needed for complete information, additional sheets may be attached.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not used)

END OF SECTION # 00 63 00

CIVIL ENGINEERING REQUEST FOR INFORMATION

| | |
|---|--------------------------------|
| | RFI NO. _____ |
| DATE: _____ | PROJECT _____ (CITY, STATE) |
| TO: _____ (CIVIL ENGINEERING CONSULTANT) | |
| FROM: _____ (GENERAL CONTRACTOR) | DRAWING NO. _____ |
| _____ | DETAIL NO. _____ |
| (PROJECT SUPERINTENDENT) | SPECS SECTION NO. _____ |
| _____ | |
| (JOB SITE FAX NUMBER) | |

RFI Type:

- | | | | |
|---|--|---|---|
| <input type="checkbox"/> Demolition | <input type="checkbox"/> Rock | <input type="checkbox"/> utilities | <input type="checkbox"/> Site Lighting |
| <input type="checkbox"/> Site Preparation | <input type="checkbox"/> Erosion Control | <input type="checkbox"/> Paving | <input type="checkbox"/> Slope Stabilization/ |
| <input type="checkbox"/> Earthwork | <input type="checkbox"/> Storm Sewer | <input type="checkbox"/> Landscape/ Irrigation | Retaining Walls |
| | | | <input type="checkbox"/> Traffic Related |
| | | | <input type="checkbox"/> Other |

Information Requested:

Requested By: _____

Reply:

Response By: _____

Date: _____

File Distribution:

DOCUMENT 00 65 02 - WAIVER AND RELEASE OF LIENS

PART 1 GENERAL

1.1 SUMMARY

- A. Document Includes: Applicability and use of statutory Waiver and Release of Lien forms promulgated by the Legislature of the State of Texas for construction projects in Texas.
- B. Related Requirements:
 - 1. The Contract for Construction (also referred to as the Agreement or the Contract)
 - 2. Conditions of the Contract (General, Supplementary, and other conditions, if any)
 - 3. Section 01 29 00 Payment Procedures
 - 4. Section 01 77 00 Contract Closeout
 - 5. Section 01 77 01 Closeout Procedures

1.2 REFERENCES

- A. Texas Property Code, Chapter 53, Subchapter L, Sections 53.281 thru 53.287 (includes the standard forms attached herewith immediately following this section):
 - 1. Form 1: Conditional Waiver for Progress Payments
 - 2. Form 2: Unconditional Waiver for Progress Payments
 - 3. Form 3: Conditional Waiver for Final Payments
 - 4. Form 4: Unconditional Waiver for Final Payments

PART 2 PRODUCTS *(not used)*

PART 3 EXECUTION

3.1 SELECTION AND USE OF WAIVER AND RELEASE OF LIEN FORMS

- A. Based on answers to the following questions, use the applicable form for the occasion:
 - 1. Is the payment a *progress* payment (partial, not final), or a *final* payment?
 - 2. Is the release *unconditional* (for a payment already received), or *conditional* (given in anticipation of a payment not yet received)?
- B. Submit the applicable form, properly executed (filled out, signed and dated) and notarized, on each occasion required (see other portions of the Contract Documents, including but not necessarily limited to the related requirements documents cited above).
- C. The wording of these forms is prescribed by the State of Texas. Questions regarding their use, execution, etc. should be directed to user's own attorney experienced in construction or lien law. This document is not to be interpreted as rendering legal advice.
- D. Even if the Contract Documents do not explicitly require submittal of Waivers and Releases of Liens for every payment (for example, omitting them for monthly progress payments), the Owner reserves the right, at its sole discretion, to require applicable Waivers and Releases of Liens, executed and notarized, for any or all payments.

END OF DOCUMENT AI

(see following pages for standard forms)

FORM 1: CONDITIONAL WAIVER FOR PROGRESS PAYMENTS

PROJECT NAME: _____
OWNER'S NAME: _____ PROJECT NUMBER _____

CONDITIONAL WAIVER AND RELEASE ON PROGRESS PAYMENT

On receipt by the signer of this document of a check from _____ (maker of check) in the sum of \$_____ payable to _____ (payee or payees of check) and when the check has been properly endorsed and has been paid by the bank on which it is drawn, this document becomes effective to release any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position that the signer has on the property of _____ (owner) located at _____ (location) to the following extent:
_____ (job description).

This release covers a progress payment for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) as indicated in the attached statement(s) or progress payment request(s), except for unpaid retention, pending modifications and changes, or other items furnished.

Before any recipient of this document relies on this document, the recipient should verify evidence of payment to the signer.

The signer warrants that the signer has already paid or will use the funds received from this progress payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project in regard to the attached statement(s) or progress payment request(s).

Date _____
_____ (Company name)
By _____ (Signature)
_____ (Printed/Typed name)
_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This _____ day of _____, 20____ A.D.

Notary Public in and for the state of _____

FORM 2: UNCONDITIONAL WAIVER FOR PROGRESS PAYMENTS

PROJECT NAME: _____

OWNER'S NAME: _____ PROJECT NUMBER _____

NOTICE: THIS DOCUMENT WAIVES RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. IT IS PROHIBITED FOR A PERSON TO REQUIRE YOU TO SIGN THIS DOCUMENT IF YOU HAVE NOT BEEN PAID THE PAYMENT AMOUNT SET FORTH BELOW. IF YOU HAVE NOT BEEN PAID, USE A CONDITIONAL RELEASE FORM.

UNCONDITIONAL WAIVER AND RELEASE ON PROGRESS PAYMENT

The signer of this document has been paid and has received a progress payment in the sum of \$_____ for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) on the property of _____ (Owner) located at _____ (location) to the following extent: _____ (job description). The signer therefore waives and releases any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position that the signer has on the above referenced project to the following extent:

This release covers a progress payment for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) as indicated in the attached statement(s) or progress payment request(s), except for unpaid retention, pending modifications and changes, or other items furnished.

The signer warrants that the signer has already paid or will use the funds received from this progress payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project in regard to the attached statement(s) or progress payment request(s).

Date _____

_____ (Company name)

By _____ (Signature)

_____ (Printed/Typed name)

_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This ____ day of _____.
20____ A.D.

Notary Public in and for the state of _____

FORM 3: CONDITIONAL WAIVER FOR FINAL PAYMENTS

PROJECT NAME: _____

OWNER'S NAME: _____ PROJECT NUMBER _____

CONDITIONAL WAIVER AND RELEASE ON FINAL PAYMENT

Project _____

Job. No. _____

On receipt by the signer of this document of a check from _____ (maker of check) in the sum of \$_____ payable to _____ (payee or payees of check) and when the check has been properly endorsed and has been paid by the bank on which it is drawn, this document becomes effective to release any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position that the signer has on the property of _____ (owner) located at _____ (location) to the following extent:
_____ (job description).

This release covers the final payment to the signer for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted).

Before any recipient of this document relies on this document, the recipient should verify evidence of payment to the signer.

The signer warrants that the signer has already paid or will use the funds received from this final payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project up to the date of this waiver and release.

Date _____

_____ (Company name)

By _____ (Signature)

_____ (Printed/Typed name)

_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This ____ day of _____.
20____ A.D.

Notary Public in and for the state of _____

FORM 4: UNCONDITIONAL WAIVER FOR FINAL PAYMENTS

PROJECT NAME: _____

OWNER'S NAME: _____ PROJECT NUMBER _____

NOTICE: THIS DOCUMENT WAIVES RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. IT IS PROHIBITED FOR A PERSON TO REQUIRE YOU TO SIGN THIS DOCUMENT IF YOU HAVE NOT BEEN PAID THE PAYMENT AMOUNT SET FORTH BELOW. IF YOU HAVE NOT BEEN PAID, USE A CONDITIONAL RELEASE FORM.

UNCONDITIONAL WAIVER AND RELEASE ON FINAL PAYMENT

Project _____

Job. No. _____

The signer of this document has been paid in full for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) on the property of _____ (owner) located at _____ (location) to the following extent: _____ (job description). The signer therefore waives and releases any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position.

The signer warrants that the signer has already paid or will use the funds received from this final payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project in regard to the attached statement(s) or progress payment request(s).

Date _____

_____ (Company name)

By _____ (Signature)

_____ (Printed/Typed name)

_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This ____ day of _____.
20____ A.D.

Notary Public in and for the state of _____

(END OF ATTACHED FORMS)

DOCUMENT 00 72 00 - GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION

- A. The General Conditions of the Contract for Construction, AIA Document A201, 2007 Edition, referenced as the General Conditions, are a part of the Contract Documents.
- B. The Contractor is specifically directed, as a condition of the Contract, to acquaint itself with the Articles of the General Conditions and to notify and apprise its subcontractors and other entities of the conditions governing the Contract for Construction.
- C. No contractual adjustments shall be due for failure of each entity to fully acquaint itself with the General Conditions.
- D. The General Conditions of the Contract may be amended by Supplementary Conditions.
- E. The provisions of the General and Supplementary Conditions and Division 1 General Requirements apply to the work specified in each Section of the Contract Specifications and indicated on the Contract Drawings.

END OF DOCUMENT 00 72 00

DOCUMENT 00 73 00 - SUPPLEMENTARY CONDITIONS

Supplement AIA Document A201, 2007 Edition as follows:

ARTICLE 1 - GENERAL CONDITIONS

1.1 BASIC DEFINITIONS

Revise the first sentence in Subparagraph 1.1.1 as follows:

1.1.1 THE CONTRACT DOCUMENTS

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement), and consist of the Agreement, the Conditions of the Contract (General, Supplementary, and other Conditions), Performance Bond, Labor and Material Payment Bond, the Drawings, the Specifications, all Addenda issued prior to execution of the Agreement and all Modifications issued after the execution of the Contract.

Add the following text to Subparagraph 1.1.3, THE WORK:

1.1.3 It also includes all supplies, skill, supervision, transportation services and other facilities and things necessary, proper or incidental to the carrying out and completion of the terms of the contract and all other items of cost or value needed to produce, construct and fully complete the public work identified by the Contract Documents.

Add the following Subparagraphs:

1.1.9 DESCRIPTION OF PARTIES

The following definitions apply to parties named in the Contract Documents.

1. Owner: Pharr-San Juan-Alamo Independent School District
Daniel King, PhD.
601 East Kelly Street
Pharr, TX 78577
Phone: 956-354-2000
2. Architect: PBK Architects
11 Greenway Plaza Blvd., 22nd Floor
Houston, Texas, 77046
Phone: 713-965-0608; Fax: 713-961-4571.
5. MEP Engineer Leaf Engineers – PBK Division
601 N.W Loop 410, Ste. 400
San Antonio, Texas, 78216
Phone: 210-638-7200
6. Aquatics Council-Hunsaker
10733 Sunset Office Dr. Ste. 400
St. Louis, MO 63127
Phone: 314-894-1245

- | | | |
|-----|--------------|---|
| 7. | Technology | Leaf Engineers – PBK Division 601 N.W Loop 410, Ste. 400 San Antonio, Texas, 78216 Phone: 210-638-7200 |
| 8. | Landscape | Heffner Design Team 4814 N. 11 th Street, Suite E McAllen, Texas 78504 Phone 956- 540 -7850 |
| 9. | Civil | Melden & Hunt, Inc. 115 W. McIntyre Edinburg, Texas 78541 Phone: 956-381-1839 |
| 10. | Geotechnical | Terracon Consultants, Inc. 1506 Mid-Cities Dr. Pharr, Texas 78577 Phone: 956-283-8254 |
| 11. | Sports | PBK Sports 11 Greenway Plaza, Blvd, 15 th Floor Houston, Texas 77046 Phone: 956-687-9421 |

1.1.10 ADDENDA

Addenda are written or graphic instruments issued prior to the execution of the Contract, which modify or interpret the proposal documents, including Drawings and Specifications, by additions, deletions, clarifications or corrections. Addenda will become part of the Contract Documents when the Construction Agreement is executed.

1.1.11 APPROVED, APPROVED EQUAL, APPROVED EQUIVALENT, OR EQUAL

The terms Approved and Approved Equal relate to the substitution of materials, equipment or procedure approved in writing by the Architect prior to receipt of proposals.

1.1.12 ABBREVIATIONS

| | |
|------------|--|
| N.I.C. | Not in contract. Indicating work not to be done by this Contractor |
| By Others; | under this Agreement. |
| By Owner; | |
| Existing | |
| AIA | American Institute of Architects |
| ACI | American Concrete Institute |
| AISC | American Institute of Steel Construction |
| AISI | American Iron and Steel Institute |
| ASA | American Standards Association |
| ASTM | ASTM International |
| AWSC | American Welding Society Code |
| FS | Federal Specification |
| NEC | National Electrical Code |
| SPR | Simplified Practice Recommendation |

SUPPLEMENTARY CONDITIONS

UL Underwriters Laboratories, Inc.

1.1.13 PROPOSAL DOCUMENTS

Proposal Documents consist of all documents bound into or referenced in the Project Manual, the Drawings, and Addenda related thereto. The Project Manual contains the Proposed Requirements, Sample Forms, Conditions of the Contract, the Specifications, and a list of Drawings, and Schedules, some of which are bound into the Project Manual (Other Drawings and Schedules are bound separately).

1.1.14 MISCELLANEOUS OTHER WORDS

Provide: Whenever the word "provide" is used in these documents, it shall mean the same as "furnish and install".

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

Add the following Subparagraphs:

1.2.4 PRECEDENCE OF THE CONTRACT DOCUMENTS

The most recent issued Document takes precedence over previous issued forms of the same Document. The order of precedence is as follows with the highest authority listed first.

- .1 The Agreement
- .2 The Addenda
- .3 Conditions of the Contract, Drawings, and Specifications shall have equal authority and are complementary documents. Should these documents disagree in themselves; the Architect will select the appropriate method for performing the work at no additional increase in the Contract Cost.

1.2.5 RELATION OF SPECIFICATIONS AND DRAWINGS

The Drawings and Specifications are correlative and have equal authority and priority. Should they disagree in themselves, or with each other, base the proposals on the most expensive combination of quality and quantity of work indicated. The appropriate method of performing the Work, in the event of the above mentioned disagreements, will be made by the Architect.

1.2.6 OPTIONAL MATERIALS, BRANDS AND PROCESSES

When more than one is specified for a particular item of Work, the choice shall be the Contractor's. The final selection of color and pattern will be made from the range available within the option selected by the Contractor, unless the item is specified to match a specific color or sample furnished. Where particular items are specified only products of those named manufacturers are acceptable. Certain specified construction and equipment details may not be regularly included as part of the named manufacturer's standard catalog equipment but shall be provided by the manufacturer as required for the proper functioning of the equipment. Reasonable minor variations in equipment are expected and will be acceptable; however, indicated and specified performance and material requirements are minimum, and will be required in addition to standard accessories. The Architect reserves the right to determine the equality of equipment and materials that deviate from any of the indicated and specified requirements.

Add Paragraph 1.7 and following Subparagraphs:

1.7 MISCELLANEOUS OTHER DEFINITIONS

1.7.1 ADDENDA, ADDENDUM

Documents issued by the Architect prior to execution of the Owner Contractor Agreement that modify or clarify the Proposal Documents. The addenda become a part of the Contract Documents

1.7.2 ALTERNATE PROPOSAL(S)

A separate amount stated on the Proposal Form which, if accepted by the Owner, will be added to or deducted from the Base Proposal. If accepted, the work that corresponds to the alternate proposal will become part of the Agreement between Owner and Contractor. Alternative proposals shall remain valid for a period of 30 days after receipt of proposals, regardless if an Owner Contractor Agreement has been executed, unless indicated otherwise herein.

1.7.3 BASE PROPOSAL

The Contractor's proposal for the Work, not including any Alternatives.

1.7.4 CONTRACT TIME

The period of time which is established in the Contract Documents for Substantial Completion of the Work.

1.7.5 DATE OF AGREEMENT

The date the Owner formally awards a Contract for Construction of the Work. This date will be inserted on the first page of the Agreement Between Owner and Contractor and shall be referenced in Performance Bond and Payment Bond forms. See also Date of Commencement of the Work.

1.7.6 DATE OF COMMENCEMENT OF THE WORK

The date that either (1) the fully executed Agreement Between Owner and contractor, or (2) a written Notice to Proceed is delivered to the Contractor. This date constitutes day zero ("0") of the stated Contract Time.

1.7.7 DATE OF FINAL COMPLETION

The end of construction. Refer Paragraph 9.10.

1.7.8 DATE OF SUBSTANTIAL COMPLETION

Refer Subparagraph 8.1.3 and Paragraph 9.8. Contractor shall be Substantially Complete by date stated in the Agreement.

1.7.9 DAY

- .1 Calendar Days: The days of the Gregorian Calendar. The Contract Time is established in Calendar Days and extensions of time granted for Regular Work Days lost, if any, will be converted to Calendar Days.
- .2 Holidays: The days officially recognized by the construction industry in this area as a holiday; normally limited to the observance days of New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day and the day after, and Christmas Day.
- .3 Regular Work Days: All calendar days except holidays, Saturdays, and Sundays. Requests for extensions of time shall be requested on the basis of Regular Work Days, and those days, if approved; will be converted to calendar days by multiplying by a factor of one and four-tenths (1.4).

Add the following Subparagraph:

There will be No Extensions of Time due to weather.

1.7.10 NOTICE TO PROCEED

A notice that may be given by the Owner to the Contractor that directs the Contractor to start the Work. It may also establish the Date of Commencement of the Work.

1.7.11 PUNCH LIST

A comprehensive list prepared by the Contractor prior to Substantial Completion to establish all items to be completed or corrected; this list may be supplemented by the Architect or Owner. Refer to Subparagraph 9.8.2.

ARTICLE 2 - OWNER

2.2 INFORMATION AND SERVICES REQUIRED OF THE OWNER

Delete the text of Subparagraph 2.2.5 in its entirety and substitute the following:

2.2.5 The Contractor will be furnished free of charge, eight (8) copies of the Drawings and Specifications for the execution of the work. The Contractor shall pay actual reproduction costs of any additional copies required.

2.4 OWNER'S RIGHT TO CARRY OUT THE WORK

Delete text of Subparagraph 2.4.1 in its entirety and substitute the following:

2.4.1 If the Contractor defaults or neglects to carry out the work in accordance with the Contract Documents and fails, after receipt of written notice from the Owner, to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such deficiencies. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the contractor the cost of correcting such deficiencies, including compensation for the Architect's additional services and expenses made necessary by such default, neglect or failure. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

2.5 OWNER'S RIGHT TO OCCUPY THE PROJECT

Add the following Subparagraphs:

2.5.1 The Owner shall have the right to occupy or use without prejudice to the right of either party, any completed or largely completed portions of the project, notwithstanding the time for completing the entire work or such portions may not have expired. Such occupancy and use shall not constitute acceptance of any work not in accordance with the Contract Documents.

2.5.2 If such prior use delays the completion of the project, the Contractor shall be entitled to extension of time, which claim shall be in writing with supporting data attached.

2.5.3 Refer to Article 11 - Insurance and Bonds regarding property insurance requirements in the event of such occupancy.

ARTICLE 3 - CONTRACTOR

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

Delete text of Subparagraph 3.2.1 and substitute the following:

3.2.2 The Contractor shall carefully study and compare the Agreement, Conditions of the Contract, Drawings, Specifications, Addenda, and Modifications and shall at once report to the Architect any error, inconsistency, or omission he may discover. Contractor shall be liable for any damage to Owner for failure to report any error, inconsistency or omission he may discover or should have discovered, but he shall not be liable to Owner or Architect for any damage resulting from such error, inconsistency or omission which he should not have discovered or which he did discover and at once so reported. Contractor shall do no work without approved Drawings and Specifications.

Add the following Subparagraphs:

3.2.5 The Contractor shall not be entitled to additional compensation for the "rework portion" of any additional work caused by his failure to carefully study and compare the contract documents prior to execution of the Work.

3.2.6 The Contractor shall make a reasonable attempt to interpret the Contract Documents before asking the Architect for assistance in interpretation. The Contractor shall not ask the Architect for observation of work prior to the Contractor's field superintendent's personal inspection of the work and his determination that the work complies with the Contract Documents. The Contractor shall arrange meetings prior to commencement of the work of all major subcontractors to allow the subcontractor to demonstrate his understanding of the documents to the Architect and to allow the subcontractor to ask for any interpretation he may require.

3.2.7 If, in the opinion of the Architect, the Contractor does not make a reasonable effort to comply with the above requirements of the Contract Documents and this causes the Architect or his Consultants to expend an unreasonable amount of time in the discharge of the duties imposed on him by the contract Documents, then the Contractor shall bear the cost of compensation for the Architect's additional services made necessary by such failure. The Architect will give the Contractor prior notice of intent to bill for additional services related to above requirements before additional services are performed.

3.2.8 If the Contractor has knowledge that any of the products or systems specified will perform in a manner that will limit the Contractor's ability to satisfactorily perform the work or to honor his Warranty, he shall promptly notify the Architect in writing, providing substantiation for his position. Any necessary changes, including substitution of materials, shall be accomplished by appropriate Modification.

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

Add the following Subparagraph:

3.3.4 The Contractor is especially cautioned to coordinate the routing of mechanical and electrical items prior to commencing these operations.

3.5 WARRANTY

Add the following Subparagraphs:

3.5.2 In the event of failure of materials, products, or workmanship, either during construction or the Correctional Period (which shall be one (1) year from the Date of Substantial Completion, except where a longer period is specified), the Contractor shall take appropriate measures to assure correction or replacement of the defective items, whether notified by the Owner or Architect. Items of work first performed after Substantial Completion shall have their warranties extended by the period of time between Substantial Completion and the actual performance of the Work.

3.5.3 Refer to warranty forms included under Section 01710 Guarantees, Certificates and Close-Out, which will be required prior to final payment.

3.5.4 Appropriately 11 months after Substantial Completion, the Contractor shall accompany the Owner and Architect on a complete walk-thru of the Project and be responsible for correcting of any additional deficiencies observed or reported.

3.6 TAXES

Delete text of Subparagraph 3.6.1, and substitute the following.

3.6.1 The Owner is exempt from the Texas Sales Tax on any purchase of tangible personal property and will issue Certificates of Exemption from the Texas Sales Tax on materials furnished by Contractors on School Construction projects. The Contractor shall give a written statement to the Owner (with a copy to the Architect) as to the proration of costs of skilled crafts, labor and materials for the project prior to awarding of a Construction Contract. The contractors shall obtain Certificates of Resale from their suppliers in order to avoid payment of the State Sales Tax on materials incorporated in School jobs. Failure of the Contractor to obtain Certificates of Resale from their suppliers shall make the Contractor responsible for absorbing the tax.

3.7 PERMITS, FEES, NOTICES AND COMPLIANCE WITH LAWS

3.7.1 Supplement Subparagraph 3.7.1, as follows:

3.7.1.1 The Owner will pay directly to the governing authority, the cost of all permanent property utility assessments and similar connection charges.

3.7.1.2 The Contractor shall pay directly all temporary utility charges, tap charges, and water meter charges. The Contractor shall secure and pay for all governing authorities' permit fees.

Delete text of Subparagraph 3.7.3 in its entirety and substitute the following:

3.7.3 It is not the Contractor's responsibility to ascertain that the contract Documents are in accordance with Applicable laws, statutes ordinances, building codes, and rules and regulations. However, if the Contractor observes, or should have observed, that portions of the Contract Documents are to variance therewith, the Contractor shall promptly notify the Architect and Owner in writing and necessary changes shall be accomplished by appropriate Modification.

3.7.3.1 If the Contractor performs Work which he knew or should have known to be contrary to applicable laws, statues, ordinances, building codes, local rules or regulations, without such notice to the Architect and Owner, the Contractor shall assume full responsibility for such Work and shall bear there attributable costs.

3.8 ALLOWANCES

Delete text of Subparagraph 3.8.1, and substitute the following:

3.8.1 The General Contractor shall include in his proposal the allowances stated in the Specifications. These stated allowances represent the cost estimate of the materials and equipment delivered and unloaded at the site. The Contractor's handling costs on site, overhead, profit, and other expenses contemplated for the allowance material and equipment shall be included in allowance only where called for in the various sections of these specifications.

The Contractor shall purchase the allowance materials and equipment as directed by the Architect on the basis of the lowest responsible proposal of at least three (3) competitive proposals. If the actual cost of the materials and equipment delivered and unloaded at the site is more or less than all the allowance estimates, the Contract Sum will be adjusted accordingly by Change Order.

3.9 SUPERINTENDENT

Delete Subparagraph 3.9.1, in its entirety and substitute the following:

3.9.1 Prime Contractor shall employ competent superintendent and necessary assistants who shall be in attendance at the Project site during the progress of the Work. The Superintendent shall be satisfactory to the Owner and shall not be changed except with the consent of the Architect, unless the Superintendent leaves the employment of the Contractor. No increase in Contract Time or Contract Sum shall be allowed in the event the Owner or Architects objects to any nominated superintendent.

3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

Add the following Subparagraph:

3.10.4 The Contractor shall submit to the Architect with each monthly Application for Payment, a copy of the progress schedule showing all modifications required to have the schedule reflect appropriate revisions and shall take whatever action is necessary to assure that the project completion schedule is met.

3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

Add the following Subparagraphs:

3.12.11 The Contractor shall submit complete drawings, data and samples to the Architect at least 30 days prior to the date the Contractor needs the reviewed submittals returned. The Contractor shall be prepared to submit color samples on any key items (such as quarry tile, vinyl wall covering, etc.) within 30 days of the award of Contract. Once samples of all key items are received, the Architect will finalize color selections.

3.12.12 The Contractor shall submit the number of copies of product data and samples which the Contractor and his subcontractors need for their use PLUS two (2) additional sets for the Architect, one (1) additional set for the Owner and one (1) additional set for each of the Architect's consultants involved with the particular Section of Work. Where shop drawings are involved, submit one (1) high quality reproducible transparency and one (1) opaque print of the shop drawing for the Architect plus one (1) additional opaque print for each of the Architect's consultants involved with the particular Section of Work. The reproducible transparency will be marked by the Architect and/or his consultants. After final review and correction of the submittal, the Contractor shall send one (1) corrected set to the Architect and one (1) to each of the Architect's consultants involved with the particular Section of Work.

3.12.13 The Contractor shall provide composite drawings within three (3) months of contract signing showing how all piping, ductwork, lights, conduit, equipment, etc. will fit into the ceiling space allotted, including clearances required by the manufacturer, by Code, or in keeping with good construction practice.

Space for all trade elements must be considered on the same drawing. Drawings shall be at 1/4 inch per foot minimum scale and shall include invert elevations and sections required to meet intended purpose.

3.15 CLEANING UP

Add the following Subparagraph:

3.15.3 Prior to the Architect's review for Substantial Completion, the Contractor shall clean exterior and interior surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces; clean equipment and fixtures to a sanitary condition; clean roofs; clean site; sweep paved areas and rake clean other surfaces; remove trash and surplus materials from the site.

Add following Paragraphs in their entirety:

3.19 REPRODUCIBLE RECORD DRAWINGS

3.19.1 At the completion of the Project, the contractor shall submit one (1) complete set of drawings with all changes made during construction, including concealed mechanical, electrical, and plumbing items. Drafting shall be compatible and the Contractor shall submit these as electronic files. The record drawings shall exclude the seal of the Architect and/or Engineer and shall have a statement added to indicate the purpose of the drawings (i.e., "AS BUILT" or "RECORD DRAWING").

3.20 PREVAILING WAGE RATES

3.20.1 No employee used in this construction may be paid less than the minimum wage rate provided herein in Article 16.

3.21 ANTITRUST VIOLATIONS

3.21.1 To permit the Owner to recover damages suffered; in antitrust violations, the Owner/Contractor Agreement shall include the following, "Contractor hereby assigns to Owner any and all claims for overcharges associated with this contract which are under the antitrust laws of the United States, 15 U.S.C.A., Sec. 1 et.seq. (1973)". The Contractor shall include this provision in his agreements with each subcontractor and supplier. Each subcontractor shall include such provisions in agreements with sub-subcontractors and suppliers.

ARTICLE 4 - ARCHITECT

4.2 ADMINISTRATION OF THE CONTRACT

Add the following text to Subparagraph 4.2.3:

4.2.3 The Architect shall endeavor to guard the Owner against defects and deficiencies in the Work.

Delete text of following Subparagraphs and substitute the following:

4.2.6 The Architect will have authority to reject Work which does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable for implementation of the intent of the Contract Documents, the Architect will have authority to require additional inspection or testing of the Work in accordance with Subparagraphs 13.5.2 and 13.5.3, whether or not such Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made reasonably and in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, material an equipment suppliers, their agents or employees, or other persons performing portions of the Work.

4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of and reasonably inferable from the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either and will not be liable for results of interpretations or decisions so rendered reasonably and in good faith.

ARTICLE 5 - SUBCONTRACTORS

5.2 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

Delete text of Subparagraphs 5.2.1, 5.2.2, 5.2.3, and 5.2.4 in their entirety and substitute the following:

5.2.1 As soon as practicable after Award of the Contract but no later than ten (10) days prior to the submittal date for the Contractor's first Application for Payment, Contractor shall furnish to the Owner and Architect in writing the names of the persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each of the principal portions of the Work. Where Subcontractors or Sub-subcontractors have been listed in the Specifications or in an Addendum as a Listed Subcontractor the proposed entity shall be one of those firms listed, unless agreement has been reached to accept a proposed Substitute Subcontractor as listed on the Proposal Form. Regarding proposed persons or entities to perform portions of the Work where no Listed Subcontractors have been listed or approved by Addendum, the Architect will promptly reply to the Contractor in writing stating whether or not the Owner or the Architect, after due investigation, has objection to any such proposed person or entity. Failure of the Owner or Architect to reply promptly shall constitute notice of no objection. Failure of the Contractor to submit the subject names in a timely manner will delay processing of the Contractor's Application for Payment.

5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made a timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made an objection under the provisions of Subparagraph 5.2.1.

5.2.3 If the Owner or Architect has objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no objection. The Contract Sum shall be increased or decreased by the difference in cost occasioned by such change and an appropriate Change Order shall be issued. However, no increase in the Contract Sum shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required in Subparagraph 5.2.1.

5.2.4 Prior to such substitution the Contractor shall notify the Architect of his intent and reasons for such proposed substitutions. The Contractor shall not change a Subcontractor, person or entity previously selected if the Owner or Architect makes objection to such change.

Add Subparagraphs 5.2.5 and 5.2.6 as follows:

5.2.5 The Contractor shall submit the list of proposed Subcontractors on Document 00 40 00 AF. The Contractor may obtain blank copies from the Architect.

5.2.6 The Contractor is required to visit the site and completely familiarize himself with the existing conditions prior to the proposal. No additional increase in the Contract amount will be provided when existing or known conditions require a certain amount of work to comply with the intent of the Contract Documents.

ARTICLE 7 - CHANGES IN THE WORK

7.2 CHANGE ORDERS

Add Subparagraph 7.2.2 as follows:

7.2.2 The cost or credit to the Owner resulting from a change in the work shall be determined in one or more of the ways listed below. The first method listed shall be used unless the Architect determines that the method is inappropriate, in which case another method shall be selected:

- A. By mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation. Where additional work is involved, the lump sum shall represent the estimated cost of labor and materials plus markups to cover overhead and profit:
 - 1. To compensate the contractor or subcontractor actually performing a part of the work for the combined cost of overhead and profit, the performing party shall be entitled to a single markup not to exceed 10% of the estimated cost of that part of the work.
 - 2. To compensate the contractor for the combined cost of overhead and profit on work performed by subcontractors, the Contractor shall be entitled to a single markup not to exceed 10% of the subcontract amount.
 - 3. When a subcontractor performs the work of a change, the 10% markup for combined overhead and profit shall be used only by the sub-subcontractor. The Contractor and Subcontractor would each be entitled to a single markup not to exceed 10% of the cost to them for the Subcontractor and sub-subcontractor, respectively.
- B. By unit prices stated in the Contract Documents or subsequently agreed upon. Additional markups for overhead and profit will not be allowed in Unit Price work.
- C. By cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee.

7.3 CONSTRUCTION CHANGE DIRECTIVES

Delete text of Subparagraph 7.3.3 in its entirety and substitute the following:

7.3.3 The cost or credit to the Owner resulting from a change in the Work shall be determined in one or more ways listed below. The first method listed shall be used unless the Architect determines that the method is inappropriate, in which case another method shall be selected.

- .1 By mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation. Where additional Work is involved, the lump sum shall represent the estimated cost of labor and materials plus markups to cover overhead and profit:

To compensate the Contractor or Subcontractor actually performing a part of the Work for the combined cost of overhead and profit, the performing party shall be entitled to a single markup not to exceed 10% of the estimated cost of that part of the Work.

To compensate the Contractor for the combined cost of overhead and profit on work performed by Subcontractors, the Contractor shall be entitled to a single markup not to exceed 10% of the subcontract amount.

When a Sub-subcontract performs the Work of a change, the 10% markup for combined overhead and profit shall be used only by the Sub-subcontractor. The Contractor and Subcontractor would each be entitled to a single markup not to exceed 10% of the cost to them from the Subcontractor and Sub-subcontractor respectively.

- .2 By unit prices stated in the Contract Documents or subsequently agreed upon. Additional markups for overhead and profit will not be allowed in Unit Price Work.
- .3 By cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee.

Add the following Subparagraph:

7.5 CHANGES FUNDED BY ALLOWANCES

7.5.1 Allowances balances may be used to fund changes in the work.

The Contractor will not be allowed an overhead and profit mark-up when changes in the work are funded by one of the Allowances. For Subcontractor and Sub-Subcontractor overhead and profit mark-up when changes in the work are funded by one of the Allowances, refer to Paragraph 7.2.2.

ARTICLE 8 - TIME

8.1 DEFINITIONS

Delete Subparagraph 8.1.2 in its entirety and substitute the following:

8.1.2 Unless agreed otherwise, the date inserted on the Agreement form and the Date of Commencement of the Work shall be as follows:

- .1 The date inserted on the first page of the Agreement form will be the date the Owner formally awards the Contract. As soon as feasible after receipt of Proposals, the Architect will present Agreement forms to the Contractor for his review and signature; the Contractor will be allowed a maximum of five (5) days from the date the prepared Agreements are presented to him to 1) obtain the required bond forms and insurance certificates and 2) return the executed Agreement and supporting documents to the Architect for transmittal to the Owner for his final review and execution.
- .2 The Date of Commencement of the Work is the date that either (1) the fully executed Agreement of (2) a written Notice to Proceed is delivered to the Contractor and constitutes day "0" (zero) of the stated Completion Time.

8.3 DELAYS AND EXTENSIONS OF TIME

Add the following Subparagraph:

8.3.4 **There will be No Extensions of Time due to weather.**

The following is a requirement of the Contract and will be included in the Agreement between Owner and Contractor under Time of Completion and the blank spaces will be completed indicating the completion date as stated on the Proposal Form.

The Work to be performed under this Contract shall be commenced and substantially completed by the date as stated on the Proposal Form, or by such dates thereafter as may be established in any written extensions granted under Article 8 of the General Conditions. The parties hereto agree that time is of the essence of this contract and that the pecuniary damages which would be suffered by the Owner, if the Contractor does not complete all work called for in the contract documents by the specified date, are in their very nature difficult of ascertainment.

It is therefore expressly agreed as a part of the consideration inducing the Owner to execute this contract that the Owner may deduct from the final payment made to the Contractor a sum equal to \$1,000.00 per calendar day for each and every calendar day beyond the agreed date which the Contractor shall require for Substantial Completion of the work included in this contract. It is expressly understood that the said sum per day is agreed upon as a fair estimate of the pecuniary damages which will be sustained by the Owner in the event that the work is not completed within the agreed time, or within the legally extended time, if any, otherwise provided for herein. Said sum shall be considered as liquidated damages only and in no sense shall be considered a penalty, said

damage being caused by additional compensation to personnel, for loss of interest on money and other miscellaneous increased costs, all of which are difficult of exact ascertainment.

Any disruption, all or in part, of Owner's use of the existing facilities or newly completed facilities, unless as agreed to beforehand or as terms of this contract, will also be subject to a sum equal to \$500.00 per calendar day for liquidated damages until the said disruption is rectified and use of the facility is returned to the Owner in it's previous condition.

Failure to complete and close-out project 60 days after Substantial Completion will result in liquidated damages being assessed in the amount of \$1,000.00 per calendar day until close-out occurs.

ARTICLE 9 - PAYMENTS AND COMPLETION

9.2 SCHEDULE OF VALUES

Add Subparagraph 9.2.2 as follows:

9.2.2 In order to facilitate the review of Applications for Payment, the Schedule of Values shall be submitted on AIA Documents G702 and G703 or other similar forms approved by the Owner, and shall include the following:

- .1 General Contractor's costs for Contractor's fee, bonds and mobilization, etc., shall be listed as individual line items.
- .2 Contractor's costs for various construction items shall be detailed. For example, concrete Work shall be subdivided into footings, grade beams, floor slabs, paving, etc. These subdivisions shall appear as individual line items.
- .3 On major subcontracts, such as mechanical, electrical and plumbing, the schedule shall indicate line items and amounts in detail (for example; underground, major equipment, fixtures, installation of fixtures, start up, etc.)
- .4 Costs for subcontract Work shall be listed without any additional of General Contractor's costs for overhead, profit or supervisions.
- .5 Where payment for stored materials may be requested prior to installation, material and labor shall be listed as separate line items.
- .6 Sample pages from an approved schedule of values are included following this document.

9.3 APPLICATIONS FOR PAYMENT

Delete Subparagraph 9.3.1 in its entirety and substitute the following:

9.3.1 At least ten (10) days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment for operations completed in accordance with the schedule of values. Prior to this submittal, the Contractor shall contact the Architect's Field Department for on-site review of the proposed application. Upon approval by the Architect's Field Department, the Application for Payment shall be notarized and submitted to the Architect.

Included shall be data required to support the Contractor's right to payment as may be required by the Owner or Architect, such as copies of requisitions from subcontractors and material suppliers, and reflecting retainage, if provided for elsewhere in the contract documents.

Delete Subparagraph 9.3.2 in its entirety and substitute the following:

9.3.2 Payments will be made on account of materials or equipment 1) incorporated in the Work and 2) Suitably stored at the site or 3) suitably stored at some off-site location provided the following conditions are met for off-site storage:

- .1 The location must be agreed to, in writing, by the Owner and Surety.
- .2 The location must be a bonded warehouse.
- .3 Surety must agree, in writing, to each request for payment.

- .4 The Contractor must bear the cost of the Owner's and Architect's expenses related to visiting the off-site storage area.

Payments for materials or equipment stored on or off the site shall be conditioned upon submission by the Contractor of bills of sale or such other procedures satisfactory to the Owner to establish the Owner's title to such materials or equipment or otherwise protect the Owner's interest, including applicable insurance (naming the Owner as insured) and transportation to the site for those materials and equipment stored off the site. Under no circumstances will the Owner reimburse the Contractor for down payments, deposits, or other advance payments for materials or equipment.

The Contractor acknowledges that the review of materials stored off site is an additional service of the Architect and shall be charged for that service. The cost for that service will be established by the Architect and is not subject to appeal.

Add the following Subparagraph:

- 9.3.4 Contractors shall submit application in quadruplicate using AIA Document G702 and G703, Application and Certificate for Payment, 1992 Edition. All blanks in the form must be completed and signatures of Contractor and Notary Public must be original on each form.

9.4 CERTIFICATES FOR PAYMENT

Add the following Subparagraph:

- 9.4.3 The Architect will affix his signature to the same form described in Paragraph 9.3.4 to signify his certification of payment provided the application is otherwise satisfactory.

9.6 PROGRESS PAYMENTS

Add the following Subparagraph:

- 9.6.8 Based upon Applications for Payment submitted to the Architect by the Contractor and Certificates for Payment issued by the Architect, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided in the conditions of the Contract as follows:

On or about the 15th day of each month 95% of the proportion of the Contract Sum properly allocable to labor, materials and equipment incorporated in the Work and 95% of the portion of the Contract Sum properly allocable to materials and equipment suitably stored at the site or at some other location agreed upon in writing by the parties, up to the first (1st) day of that month; less the aggregate of previous payments in each case; and upon Substantial Completion of the entire work, a sum sufficient to increase the total payments to 95% of the Contract Sum less such retainages as the Architect shall determine for all incomplete work and unsettled claims.

9.7 FAILURE OF PAYMENT

Delete the phrase "or awarded by binding dispute resolution".

9.8 SUBSTANTIAL COMPLETION

- 9.8.1 Add the following:

The following items are a partial list of requirements, as applicable to the Project, that must be completed prior to the established Substantial Completion:

1. All fire alarm system components must be completed and demonstrated to the Owner.
2. Local fire marshal approval certificate must be delivered to the Owner.
3. All exterior clean-up and landscaping must be complete.
4. All final interior clean-up must be complete.

5. All HVAC air and water balancing must be complete.
6. All Energy Management Systems must be complete and fully operational and demonstrated to the Owner.
7. All communications equipment, telephone system, and P.A. systems must be complete and demonstrated to the Owner.
8. All final lockset cores must be installed and all final Owner directed keying completed.
9. All room plaques and exterior signage must be completed.
10. All Owner demonstrations must be completed including kitchen equipment, HVAC equipment, plumbing equipment, and electrical equipment.
11. A final certificate of occupancy must be signed by the Contractor and delivered to the Owner.
12. All operation and maintenance manuals are delivered and approved ("D-slant" ring binders in triplicate).

9.10 FINAL COMPLETION AND FINAL PAYMENT

At Subparagraph 9.10.2, modify as follows:

- .1 On line 8, delete the phrase "if any".
- .2 On line 8, delete the phrase "If required by the Owner".

Add the following to Subparagraph 9.10.2:

Prior to final payment, the Contractor shall submit in triplicate to the Architect the following completed forms:

1. Contractor's Affidavit of Payment of Debts and Claims, AIA Document G706.
2. Contractor's Affidavit of Release of Liens, AIA Document G706A.
3. Consent of Surety to Final Payment, AIA Document G707.
4. General Contractor's Guarantee - notarized
5. Subcontractor's Guarantee - notarized
6. Subcontractor's Lien Releases - signed and notarized on a same piece of paper.
7. Each Bidder (and subcontractor and supplier submitting a bid to a Bidder) shall submit a notarized affidavit stating that no asbestos, PCB, or lead, except for flashing in roofing, containing building materials were used.
8. Maintenance and inspection manuals. Three (3) sets of each bound in a 3 inch "D-slant" ring binder.
9. Record drawings-electronic files.
10. Final list of subcontractors.

Documents identified as affidavit must be notarized. Manuals shall contain an index listing the information submitted. The index sections will be divided and identified by tabbing each section as listed in the index.

Upon request, the Architect will furnish the Contractor with blank copies of the forms listed above. Final payment, constituting the entire unpaid balance of the Contract Sum shall be paid by the Owner to the Contractor 31 days after substantial completion of the work unless otherwise stipulated in the Certificate of Completion, the contract fully performed, and Final Certificate of Payment has been issued by the Architect.

The Owner may accept certain portions of the work as being complete prior to the acceptance of the entire project. If certain areas are accepted by the Owner as being complete, and if the Contractor has completed all of the requirements for final payment of that portion of work, then the Owner may release retainage for that area/portion of work. Amounts of retainage shall be agreed upon by both Owner and Contractor prior to final acceptance of these areas.

Refer to Section 01 77 00 Closeout Procedures for warranties, certificates, and close-out for additional requirements.

ARTICLE 10 - PROTECTION OF PERSONS AND PROPERTY

10.3 HAZARDOUS MATERIALS

Delete text of Subparagraph 10.3.2 in its entirety and substitute the following:

10.3.2 If requested in writing by the Contractor, the Owner shall obtain the services of a licensed laboratory to verify a presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to verify that it has been rendered harmless. If requested in writing by the Contractor or Architect, the Owner shall furnish in writing to the Contractor and Architect, the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of such material or substance or who are to perform the task of removal or safe containment of such material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection.

Add the following Subparagraphs:

10.7 ASBESTOS, LEAD OR PCBs CONTAINING MATERIALS

10.7.1 The contractor and each subcontractor, prior to final payment, shall submit a notarized statement on their letterhead certifying "to the best of their information, knowledge, and belief asbestos, asbestos containing materials, and PCBs have not been used or incorporated into the Work and lead or lead bearing materials have not been incorporated into potable water systems." For the purpose of definition as used in this statement, the term "potable water systems" includes, but is not limited to, those water systems for drinking fountains, all sinks, showers, bath tubs, residential and commercial kitchen equipment, ice machines, and hose bibbs, as applicable to the project. The Contractor shall also obtain such statements from Subcontractors and all such statements shall be notarized.

ARTICLE 11 - INSURANCE AND BONDS

11.1 CONTRACTOR'S LIABILITY INSURANCE

Add the following to Paragraph 11.1.3:

11.1.3.1 Proof of insurance shall be evidenced on 1) an original ACORD Certificate of Insurance 25-N (1/95) and 2) an original Supplemental Attachment for ACORD Certificate of Insurance 25-S (1/95), AIA Document G715-1991, indicating the minimum Contractor's Insurance required. The Contractor is urged to carry such additional insurance as he may deem appropriate to provide protection from risks assumed under this contract. The Contractor shall fill in the blank spaces on this form and submit one (1) copy each of the completed Certificate of Insurance forms to the Owner and Owner prior to commencement of the Work. The required insurance must be written by a Company licensed to do business in the State of Texas and be acceptable to the Owner.

Contractor's Liability Insurance: Insurance described in Paragraph 11.1 of AIA Document A201, 1997 Edition, shall be for the following minimum limits:

A. Worker's Compensation Insurance Coverage

Definitions:

Certificate of coverage ("Certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the commission, or a coverage agreement (TWCC-81, TWCC-82, TWCC-83, or TWCC-84), showing statutory workers' compensation insurance coverage for the person's or entity's employees providing services on a project, for the duration of the project.

Duration of the project - includes the time from the beginning of the work on the project until the contractor's/person's work on the project has been completed and accepted by the governmental entity.

Persons providing services on the project ("subcontractor" in Texas Labor Code 406.096) - includes all persons or entities performing all or part of the services the contractor has undertaken to perform on the project, regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity that furnishes persons to provide services on the project. "Services" shall include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a project. "Services" does not include activities unrelated to the project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

1. The contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code 401.011 (44) for all employees of the contractor providing services on the project for the duration of the project.
2. The contractor must provide a certificate of coverage to the governmental entity prior to being awarded the contract.
3. If the coverage period shown on the contractor's current certificate of coverage ends during the duration of the project, the contractor must, prior to the end of the coverage period, file a new certificate of coverage with the governmental entity showing the coverage has been extended.
4. The contractor shall obtain from each person providing services on a project, and provide to the governmental entity:
 - a. a certificate of coverage, prior to that person beginning work on the project, so the governmental entity will have on file certificates of coverage showing coverage for all persons providing services on a project; and
 - b. no later than seven (7) days after receipt by the contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.
5. The contractor shall retain all required certificates of coverage for the duration of the project and one year thereafter.
6. The contractor shall notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project.
7. The contractor shall post on each project site a notice, in the text, form and manner prescribed by the Texas Workers' Compensation Commission, informing all persons providing services on the project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.
8. The contractor shall contractually require each person with whom it contracts to provide services on a project, to:
 - a. provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011 (44) for all of its employees providing services on the project, for the duration of the project;

- b. provide to the contractor, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;
 - c. provide the contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;
 - d. obtain from each other person with whom it contracts, and provide to the contractor:
 - 1) a certificate of coverage, prior to the other person beginning work on the project; and
 - 2) a new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project.
 - e. retain all required certificates of coverage on file for the duration of the project and for one year thereafter;
 - f. notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provisions of coverage of any person providing services on the project; and
 - g. contractually require each person with whom it contracts to perform as required by paragraphs a - g, with the certificates of coverage to be provided to the person for whom they are providing services.
9. By signing this contract or providing or causing to be provided a certificate of coverage, the contractor is representing to the governmental entity that all employees of the contractor who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of self-insured, with the commission's Division of Self-Insurance Regulation. Providing false or misleading information may subject the contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.
10. The contractor's failure to comply with any of these provisions is a breach of contract by the contractor which entitles the governmental entity to declare the contract void if the contractor does not remedy the breach within ten days after receipt of notice of breach from the governmental entity.
11. The Contractor shall post the following language:

REQUIRED WORKERS' COMPENSATION COVERAGE

"The law requires that each person working on this site or providing services related to this construction project must be covered by workers' compensation insurance. This includes persons providing, hauling, or delivering equipment or materials, or providing labor or transportation or other service related to the project, regardless of the identity of their employer or status as an employee."

"Call the Texas Workers' Compensation Commission at 512 - 440 - 3789 to receive information on the legal requirements for coverage, to verify whether your employer has provided the required coverage, or to report an employer's failure to provide coverage."

B. Comprehensive General Liability Minimum Limits

| | |
|---------------|---|
| Bodily Injury | \$1,000,000/occurrence \$1,000,000/aggregate, products & completed operations \$1,000,000/occurrence \$1,000,000/aggregate |
|---------------|---|

Or

\$1,000,000 combined single limit for BI & PD

Coverage shall include

1. Premises - Operations;
2. Contractor's Protective Liability (if any work sublet);
3. Contractual Liability to cover indemnity agreement of "Hold Harmless" clause in contract;
4. Property Damage Liability insurance shall include coverage for the following hazards:
 - a. Damage to completed or partially completed work.
5. Personal Injury Liability in a minimum limit of \$500,000 with employment exclusion deleted;
6. Broad Form C G L Endorsement shall be included;
7. Waiver of Subrogation Endorsement shall be included in favor of (District Name) Independent School District/Agents;
8. Thirty day notice of cancellation or material change endorsement in favor of, (District Name) Independent School District/Agents.
9. The Owner to be named as additional insured on Contractor's policy.
10. The Owner shall be named additional insured on the Contractor's policy as to the subject job.

| | |
|--|--|
| C. <u>Comprehensive Automobile Liability</u> | <u>Minimum</u> |
| Bodily Injury | \$500,000/person \$1,000,000/occurrence |
| Property Damage | \$1,000,000/occurrence |

Or

\$1,000,000 combined single limit for BI & PH.

Coverage Shall Include

1. All owned, hired and non-owned autos of the Contractor;
2. Waiver of subrogation Endorsement in favor of (District Name) Independent School District/Agents;
3. Thirty day notice of cancellation of material change endorsement in favor of (District Name) Independent School District/Agents;
4. (District Name) Independent School District/Agents to be named as additional insured on Contractor's policy.

| | |
|------------------------------|---|
| D. <u>Umbrella Liability</u> | <u>Minimum Limits</u> |
| | \$1,000,000/occurrence \$1,000,000/aggregate |

Coverage Shall Include:

1. Waiver of Subrogation Endorsement in favor of (District Name) Independent School District/Agents;

2. Thirty day notice of cancellation or material change endorsement in favor of (District Name) Independent School District/Agents;
3. (District Name) Independent School District/Agents to be named as additional insured on Contractor's policy.

11.1.3.2 Property Insurance: The Contractor purchase insurance described in Paragraph 11.3 of AIA Document A201, 1997 Edition, to the full amount of the contract, with the Owner as an additional insured.

11.1.3.3 Waivers of Subrogation: Shall be to the benefit of (District Name) Independent School District or its agents, only and the respective policies listed in Article 11 shall be endorsed accordingly.

11.1.3.4 Certificate of Insurance: The Contractor shall furnish the Owner, Certificates of Insurance showing evidence of coverages required above, prior to beginning construction under this contract. Such certificates shall indicate that policies will not be reduced or canceled without thirty days prior notice to Owner. The required insurance must be written by a company licensed to do business in the State of Texas at the time the policy is issued. The insurance company must be acceptable to the Owner and said insurance companies must have a rating in the current Best's of at least A:XIII.

11.1.3.5 Indemnification: Contractor assumes the entire responsibility and liability and will indemnify and hold (District Name) Independent School District harmless, its agents, servants and employees from and against any and all losses, expenses, demands and claims of whatsoever character that may be claimed or asserted to suit brought against (District Name) Independent School District, its agents, servants and employees by any person, firm or corporation, including any employee or officer of Contractor its Subcontractor, on account of an actual or alleged:

Illness, bodily injury, or death occurring to any person whomsoever (including both parties and their respective officers, agents and employees) or arising out of, in connection with, or resulting from the actual or alleged activities of Contractor or any Subcontractor and their respective officers, agents and employees in the performance of the work in accordance with this Agreement. Contractor agrees that the above indemnification and hold harmless applies to, but is not limited to suits, actions or claims arising under the Structural Work Law (4811.Rev. Stat., PAR 60-69) Protection of Adjacent Land Owners Act (70 111. Rev. Stat., PAR 10), and any other similar law or statute of any other state.

Contractor further agrees to indemnify, protect and defend (District Name) Independent School District against any claim asserted, or suit brought against (District Name) Independent School District by virtue of the action of Contractor or any Subcontractor as heretofore set forth and pay judgment rendered in any such action(s); provided, however that (District Name) Independent School District shall have the right if it so elects to participate at its own expense in the defense of any such claims or suit, but participation shall not operate to affect Contractor's liability and obligations hereunder.

11.4 PERFORMANCE BOND AND PAYMENT BOND

Supplement to Article 11.

11.4.1 The Performance Bond Form and Labor and Material Payment Bond - Substitute the following for Subparagraph 11.4.1 as set forth below:

The Contractor shall furnish a Statutory Performance Bond in an amount equal to One Hundred Percent (100%) of the Contract Sum as security for the faithful performance of this Contract and also a Statutory Labor and Material payment Bond in an amount not less than One Hundred Percent (100%) of the Contract Sum as security for the payment for all persons performing labor on the project under this Contract and furnishing materials in connection with this Contract. The Performance Bond and the Labor and Material Payment Bond may be in one or in separate instruments in accordance with local law and shall be delivered to the Owner not later than the date of execution of the Contract.

- A. The Contractor shall provide an affidavit showing proof that his bonding company meets the following criteria:
 - 1. The Bonding Company must be domiciled in the United States.
 - 2. The Bonding Company must be licensed in the State of Texas.
 - 3. The Bonding Company must be acceptable to the Owner.
- B. Bond forms shall be subject to the Owner's approval. File copies of the bond with the County Clerk and furnish the Owner a file receipt.
- C. Performance and payment bonds shall remain in force throughout the warranty period of the contract.
- D. The work will not be started until the bonds and issuing companies have been accepted as satisfactory by the Owner.
- E. The original bonds will be delivered to the Owner with an attached authorization power of attorney.

ARTICLE 13 - MISCELLANEOUS PROVISIONS

13.6 INTEREST

Delete Subparagraph in its entirety.

ARTICLE 14 - TERMINATION OR SUSPENSION OF THE CONTRACT

Add the following Subparagraph:

14.2.5 Contractor hereby assigns the Owner any and all claims for overcharges associated with this Contract which arise under the antitrust laws of the United States, 15 U.S.C.A. Section 1 ET.SEQ. (1973).

14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

Delete Subparagraph 14.4.3 in its entirety and replace with the following Subparagraph:

14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment from the Owner on the same basis provided in Subparagraph 14.1.3.

Add the following Article:

ARTICLE 15 - CLAIMS AND DISPUTES

15.1 CLAIMS

Delete the text of Subparagraphs 15.1.1 and 15.1.3 in their entirety and substitute the following:

15.1.1 Definition. A Claim is a demand or assertion by one of the parties seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner, Architect and Contractor arising out of or relating to the Contract.

15.1.3 Continuing Contract Performance. Pending final resolution of a Claim, unless otherwise agreed in writing, the Contractor shall proceed diligently with performance of the Contract.

15.2 INITIAL DECISION

Delete the text of Subparagraph 15.2.1 and 15.2.2 in their entirety and substitute the following:

15.2.1 Decisions of Architect. Claims including those alleging an error or omission by the Architect shall be referred initially to the Architect for action. If the parties are unable to agree, appeal shall be as stated at ARTICLE 15A.

ARTICLE 15A: Any claims, disputes, or matters arising out of this contract between the Architect, Owner and Contractor, or any combination of those parties, shall be submitted to a court of appropriate jurisdiction.

15.2.2 The Architect will review Claims and taken one or more of the following preliminary actions within ten (10) days of receipt of a Claim: (1) request Additional supporting data from the claimant; (2) submit a schedule to the parties indicating when the Architect expects to take action; (3) reject the Claim in whole or in part, stating reasons for rejection;; (4) recommend approval of the Claim by the other party or (5) suggest a compromise. The Architect shall notify the surety, if any, of the nature and amount of the Claim.

Add the following Subparagraph:

15.2.9 If a Claim has not been resolved after consideration of the foregoing and of further evidence presented by the parties or requested by the Architect, the Architect will notify the parties in writing that the Architect's decision will be made within seven (7) days.

Upon expiration of the time period, the Architect will render to the parties the Architect's written decision relative to the Claim, including and change in the Contract Sum or Contract Time or both. If there is a surety and there appears to be possibility of a Contractor's default, the Architect shall notify the surety and request the surety's assistance in resolving the controversy.

15.4 ARBITRATION

Delete Subparagraphs 15.4.1, 15.4.1.1, 15.4.3, and 15.4.2 in their entirety and all other references to arbitration.

Add the following Subparagraph:

15.4.1 Any claims, disputes, or matters arising out of this contract between the Contractor and the Owner or the Architect not settled by mediation, shall be submitted to a court of appropriate jurisdiction. It is understood and agreed that, in the event that any dispute, controversy, or conflict arises during the design and construction of the Project or following its completion, the parties hereto will cooperate in good faith, if possible, to resolve the issues without resorting to litigation. Should the parties be unable to reach agreement, an independent mediator may be selected by mutual consent of the parties to assist in a further effort to resolve the dispute. Furthermore, if the parties mutually agree to mediation, each party included in the mediation will bear an equal share of all costs related to the mediation.

"Any claims, disputes or matters arising out of the contract will be submitted to mediation only upon the mutual consent of the parties. In the event that mutual consent is not achieved, the parties are free to pursue any claims, disputes or matters in any manner allowed by law."

ARTICLE 16 - LABOR STANDARDS

16.1 PREVAILING WAGE RATES

16.1.1 Contractor and each Subcontractor shall pay to all laborers, workmen, and mechanics employed in execution of this Contract not less than rates set forth by law and as noted in the following Wage Rate Scale, for each craft or type of workman or mechanic needed to execute Contract.

16.1.21 Determination of prevailing wages shall not be construed to prohibit payment of more than rates named.

END OF DOCUMENT 00 73 00

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Phased construction.
 - 4. Work by Owner.
 - 5. Work under separate contracts.
 - 6. Purchase contracts.
 - 7. Owner furnished products.
 - 8. Owner furnished, Contractor installed products.
 - 9. Access to site.
 - 10. Coordination with occupants.
 - 11. Work restrictions.
 - 12. Specification and drawing conventions.
 - 13. Miscellaneous provisions.

1.3 PROJECT INFORMATION

- A. Project Identification: PJSA ISD New Swimming Facilities
 - 1. Project Location:
 - 1) PSJA High School
805 West Ridge Road
San Juan, Texas 78589
 - 2) PSJA Memorial High School
800 South Alamo Road
Alamo, Texas 78516
- B. Owner:
 - 1. Owner's Representative: Mr. Daniel King, PhD, Superintendent
 - 2. Owner's Representative: Mr. Jerry Lopez, Project Manager
- C. Architect: PBK Sports, Houston, Texas.
 - 1. Architect's Representative: Mr. David I. Iglesias, Client Executive
- D. Consultants: Additional design professionals have been retained who have prepared designated portions of the Contract Documents

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following: New 6,700_SF aquatic swimming pool facility, one each at PSJA High School (San Juan, Texas) and Memorial High School (Alamo, Texas). Base Bid scope of work to include main building structure, Instructional Pool and Competition Pool, bleachers and bleacher canopy (Avadek-type) and canopies at main building over all public doors and storefront systems.
- B. Alternate No. 1 shall include the Pre-Engineered Metal Canopy structure over the two main pools. Include alternate lighting as indicated. Include masonry column wraps as indicated. Include underground drainage to each of the canopy downspouts as indicated. Exclude the bleacher canopy (Avadek-type) and associated drainage. Exclude the wall canopies over all public doors and storefronts.
- C. Alternate No. 2 shall include the Diving Pool, surrounding trench drain, bleachers, associated Pool Equipment and MEP systems to meet the requirements of all three swimming pools.
- D. Type of Contract: Project will be constructed under a competitive sealed proposal (CSP) contract.

1.5 WORK BY OWNER AND UNDER SEPARATE CONTRACTS

- A. Owner Furnished, Contractor Installed Products (OFCI): The Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner furnished products and making building services connections when applicable.
 - 1. Owner Furnished Products: Coordinate with Owner.

1.6 ACCESS TO SITE

- A. Use of Site: Limit use of Project site to Work in areas and areas within the Contract limits indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
 - 1. Limits: The drawings indicate the limits of the construction operations.
 - 2. Driveways, Walkways, and Entrances: Keep driveways, parking areas, student drop off and pick up points, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, the students, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in weathertight condition throughout construction period. Repair damage caused by construction operations.

1.7 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform Work to prevent interference with Owner's day to day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

- B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 - 1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 - 3. Before limited Owner occupancy, ensure mechanical and electrical systems are fully operational, and required tests and inspections and start up procedures are successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 - 4. Upon occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.8 WORK RESTRICTIONS

- A. Work Restrictions: Comply with restrictions on construction operations. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On Site Work Hours: Limit Work in the existing building to normal working hours, Monday through Friday, unless otherwise indicated. Coordinate with Owner when it is necessary to extend working hours or Work on weekends.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and after providing temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than two weeks in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Owner not less than two weeks in advance of proposed disruptive operations.
 - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Controlled Substances, Firearms, and Explosive Devices: Use of tobacco products, controlled substances, firearms, and explosive devices on the site is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on site. Require personnel to use identification tags at all times.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on site.
 - 1. Maintain list of approved screened personnel with Owner's representative.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

- B. Division 1 General Requirements: Requirements of Sections in Division 1 apply to the Work of each specification section.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 CONSTRUCTION SCHEDULE

- A. The Owner has a critical need for the Work to begin upon Notice to Proceed and shall be Substantially Complete within **300 Consecutive Calendar Days**. There will be No Extensions of Time due to weather.

END OF SECTION 01 10 00

SECTION 01 21 00 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements governing allowances.
 - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include
 - 1. Lump sum allowances.
 - 2. Unit cost allowances.
 - 3. Quantity allowances.
 - 4. Contingency allowances.
 - 5. Testing and inspecting allowances.

1.3 COORDINATION

- A. Coordinate allowance items with other portions of the Work.

1.4 LUMP SUM, UNIT COST, AND QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.5 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by Architect for Owner's purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. Contractor's related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.

- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.6 TESTING AND INSPECTING ALLOWANCES

- A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
- B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
- C. Costs of services not required by the Contract Documents are not included in the allowance.
- D. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to Owner by Change Order.

1.7 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 - 3. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit cost allowances.
 - 4. Owner reserves the right to establish the quantity of Work in place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
 - 2. No change to Contractor's indirect expense is permitted for selection of higher or lower priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related Work.

3.3 SCHEDULE OF ALLOWANCES

- A. **Owner's Contingency Allowances: \$100,000.00**
- B. **MEPT Contingency Allowance: \$50,000.00**
- C. **Steel Contingency Allowance: \$35,000.00**

END OF SECTION 01 21 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A.** Section includes: Administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A.** Alternate: An amount proposed by bidders and stated on the Bid Form for certain Work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1.** Alternates described are part of the Work when enumerated in the Agreement.
 - 2.** The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A.** Coordination: Revise or adjust affected adjacent Work as necessary to completely integrate Work of the alternate into Project.
 - 1.** Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B.** Notification: Forty-eight (48) hours following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
- C.** Execute accepted alternates under the same conditions as other Work of the Contract.
- D.** Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Pre-Engineered Metal Canopy over Competition Pools

1. Provide alternate pricing to furnish and install Pre-Engineering Metal Canopy as indicated at both PSJA High School and PSJA Memorial HS New Swimming Facilities. Include alternate lighting as indicated. Include masonry column wraps as indicated. Include underground drainage to each of the canopy downspouts as indicated. Exclude the Pre-Engineered Aluminum Canopy (Avadek-type) over the bleachers, associated drainage and wall canopies over all public doors and storefronts.

B. Alternate No. 2: Diving Pools

1. Provide alternate pricing for the Diving Pools, surrounding trench drain, bleachers, associated Pool Equipment and MEP Systems as indicated in the plans and specifications at both PSJA High School and PSJA Memorial High School New Swimming Facilities.

END OF SECTION 01 23 00

SECTION 01 25 13 - PRODUCT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Specified product compliance, and product quality assurance.
- B. Specific administrative and procedural requirements for handling requests for substitutions made prior to award of Contract.
- C. Requirements for product delivery, storage and handling.

1.3 RELATED REQUIREMENTS

- A. Instructions to Offerors: Product options and procedures for submittal of requests for substitutions during the Proposal period.

1.4 DESCRIPTION OF REQUIREMENTS

- A. Definitions: Definitions used in this Section are not intended to negate the meaning of other terms used in the Contract Documents, including such terms as "specialties", "systems", "structure", "finishes", "accessories", "furnishings", "special construction", and similar terms. Such terms are self-explanatory and have recognized meanings in the construction industry.
 - 1. Products: Shall mean items purchased for incorporation in the Work, regardless of whether they were specifically purchased for the project or taken from the Contractor's previously purchased stock. The term "product" as used herein includes the terms "material", "equipment", "system", and other terms of similar intent.
 - a. Named Products: Are those identified by the use of the manufacturer's name for a product, including such items as a make or model designation, as recorded in published product literature, of the latest issue as of the date of the Contract Documents.
 - b. Specified Products: same as Named Products.
 - 2. Materials: Shall mean products that must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form units of work.
 - 3. Equipment: Is defined as a product with operational parts, regardless of whether motorized or manually operated, and in particular, a product that requires service connections such as wiring or piping.

1.5 PRODUCT QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same generic kind, from a single source, for each unit of work.
 - 1. When it is discovered that specific products are available only from sources that do not or cannot produce an adequate quantity to complete project requirements in a timely manner, consult with the Architect/Engineer for a determination of what product quantities are most important before proceeding. The Architect/Engineer will designate those qualities, such as visual, structural, durability, or compatibility, that are most important. When the Architect/Engineer's determination has been made, select products from those sources that produce products that possess the most important qualities, to the fullest extent possible.

- B. Compatibility of Options: Compatibility of products is a basic requirement of product selection. When the Contractor is given the option of selecting between two (2) or more products for use on the project, the product selected must be compatible with other products previously selected, even if the products previously selected were also Contractor options. The complete compatibility between the various choices available to the Contractor is not assured by the various requirements of the Contract Documents, but must be provided by the Contractor.
- C. Or Equal:
 - 1. Where the phrase "or equal", "or equivalent", "or Architects approved equal", or similar phrasing, occurs in the Proposal Documents, do not assume that materials, equipment, or methods of construction will be approved by the Architect unless the item has been specifically approved for this Work by the Architect.
 - 2. The decision of the Architect shall be final.
- D. Where a proposed substitution involves the work of more than one (1) contractor, each contractor involved shall cooperate and coordinate the work with each other contractor involved, so as to provide uniformity and consistency and to assure the compatibility of products.
- E. Foreign Product Limitations: "Foreign products" as distinguished from "domestic products" are defined as products that are either manufactured substantially (50 percent or more of value) outside of the United States and its possessions, or produced or supplied by entities known to be substantially owned (more than 50 percent) by persons who are not citizens of nor living within the United States and its possessions.
 - 1. Except under one (1) of the following conditions, select and provide domestic, not foreign, products for inclusion in the Work.
 - a. There is no domestic product available that complies with the requirements of the Contract Documents.
 - b. Available domestic products that comply with the requirements of the Contract Documents are available only at prices or other procurement terms that are substantially higher (25 percent or more) than for available foreign products that comply with the requirements of the Contract Documents.
 - c. At the discretion of the Architect or Owner.
 - 2. Final determination and acceptance will be the responsibility of the Architect.
- F. Standards: Refer to Section 01 41 00, Regulatory Requirements for the applicability of industry standards to the products specified for the Project, and for the acronyms used in the text of the Specification Sections.

1.6 SUBSTITUTIONS OF PRODUCTS

- A. The products described in the Proposal Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution. The materials and equipment named in, and the procedures covered by these specifications have been selected as a standard because of quality, particular suitability or record of satisfactory performance. It is not intended to preclude the use of equal or better materials or equipment provided that same meets the requirements of the particular project and is approved in an Addendum as a substitution prior to the submission of proposals.
- B. No substitution will be considered prior to receipt of proposals unless written request for approval has been received by the Architect at least seven (7) days prior to the date for receipt of proposals. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and any other information necessary for an evaluation. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

- C. If the Architect approves any proposed substitution prior to receipt of proposals, such approval will be set forth in an Addendum. Offerors shall not rely upon approvals made in any other manner.
- D. The Architect and Owner reserve the right to disapprove the use of any manufacturer who in their judgment is unsuitable for use on the Project and that decision will be final
- E. The following are not considered as substitutions:
 - 1. Revisions to the Contract Documents, when requested by the Owner, Architect, or any of their consultants are considered as "changes" not substitutions.
 - 2. Specified Contractor options on products and construction methods included in Contract Documents are choices made available to the Contractor and are not subject to the requirements specified in this Section for substitutions.
 - 3. Except as otherwise provided in the Contract Documents, the Contractor's determination of and compliance with governing authorities do not constitute "substitutions" and do not constitute a basis for change orders.
- F. The following may be considered as a reason for a request for substitution:
 - 1. The request is directly related to an "or approved equal" clause or similar language in the Contract Documents.
 - 2. The specified product or method of construction cannot be provided within the Contract Time in accordance with paragraph below concerning availability of specified items.
 - 3. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 - 4. A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other consideration of merit, after deducting offsetting responsibilities the Owner may be required to bear. These additional responsibilities may include such considerations as additional compensation to the Architect/Engineer for redesign and evaluation services, the increased cost of other work by the Owner or separate contractors, and similar considerations.
 - 5. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
 - 6. The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
 - 7. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.
- G. Availability of specified items:
 - 1. Verify prior to submittal of Proposal that all specified items will be available in time for installation during orderly and timely progress of the work.
 - 2. In the event specified items will not be so available, notify the Architect prior to receipt of Proposals. Submit Request for Substitutions in accordance with this section.
 - 3. The request will not be considered if the product or method cannot be provided as a result of the Contractor's failure to pursue the work promptly or coordinate activities properly.
 - 4. Costs of delays because of non-availability of specified items, when such delays could have been avoided by the Contractor, will be back-charged as necessary and shall not be borne by the Owner.
- H. A request constitutes a representation that Offeror:
 - 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 - 2. Will provide same warranty for Substitution as for specified product, except when inability to provide specified Warranty is reason for request for substitution as described above.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.

4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse the Owner and pay for all costs, including Architect/Engineer's redesign and evaluation costs resulting from the use of the proposed substitution, or for review or redesign services associated with re-approval by authorities having jurisdiction.

I. No substitutions will be considered after the Award of Contract.

1.7 SUBSTITUTION REQUEST SUBMITTAL

- A. Requests for Substitutions: Submit three (3) copies of each request for substitution. In each request identify the product or fabrication or installation method to be replaced by the substitution; include related Specifications Section and Drawing numbers, and complete documentation showing compliance with the requirements for substitutions. Include, as appropriate, with each request, the following information:
1. Product data, drawings and descriptions of products, fabrication and installation procedures.
 2. Samples, where applicable or requested.
 3. A detailed comparison of the significant qualities of the proposed substitution with those of the work originally specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect, where applicable.
 4. Coordination information, including a list of changes or modifications needed by other parts of the work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
 5. A statement indicating the effect the substitution will have on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 6. Cost information, including a proposal of the net change, if any in the Contract Sum.
 7. Certification by the Contractor to the effect that, in the Contractor's opinion, after thorough evaluation, the proposed substitution will result in work that in every significant respect is equal-to or better than the work required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
 8. A statement indicating the Contractor will reimburse the Owner and pay for all costs, including Architect/Engineer's re-design and evaluation costs resulting from the use of the proposed substitution.
- B. Work-Related Submittals: The Contractor's submittal of, and the Architect/Engineer's acceptance of, Shop Drawings, Product Data, or Samples which are related to work not complying with the Contract Documents, does not constitute an acceptance or valid request for a substitution, nor approval thereof.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. General: Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft. Control to prevent overcrowding of construction spaces or overloading of structure. In particular, coordinate delivery and installation to ensure minimum holding or storage times for items known or recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other sources of loss.
1. Deliver products to the site in the manufacturer's sealed containers or other packaging system, complete with labels intact, and instructions for handling, storage, unpacking, installing, cleaning and protecting.
 2. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation or potential degradation of product.

3. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
4. Store products at the site or in a bonded and insured off-site storage facility or warehouse in a manner that will facilitate inspection and measurement of quantity or counting of units. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
5. Store heavy materials away from the project structure or in a manner that will not endanger the supporting construction.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT COMPLIANCE

- A. General: Requirements for individual products are indicated in the Contract Documents; compliance with these requirements is in itself a contract requirement. These requirements may be specified in any one (1) of several different specifying methods, or in any combination of these methods. These methods include the following:
 1. Proprietary.
 2. Descriptive.
 3. Performance.
 4. Compliance with Reference Standards.
- B. Compliance with codes, compliance with graphic details, allowances, and similar provisions of the Contract Documents also have a bearing on the selection process
- C. Procedures for Selecting Products: The Contractor's options in selecting products are limited by requirements of the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects. Required procedures include, but are not limited to the following for the various indicated methods of specifying:
 1. Proprietary and Semi-Proprietary Specification Requirements:
 - a. Single Product Name: Where only a single product or manufacturer is named, provide the product indicated, unless the specification indicates the possible consideration of other products. Advise the Architect/Engineer before proceeding, when it is discovered that the named product is not a reasonable or feasible solution.
 - b. Two (2) or More Product Names: Where two (2) or more products or manufacturers are named, provide one (1) of the products named, at the Contractor's option. Exclude products that do not comply with specification requirements. Do not provide or offer to provide an unnamed product, unless the specification indicates the possible consideration of other products. Advise the Architect/Engineer before proceeding where none of the named products comply with specification requirements, or are not feasible for use. Where products or manufacturers are specified by name, accompanied by the term "or approved equal" or similar language, comply with this Section regarding "substitutions" to obtain approval from the Architect/Engineer for the use of an unnamed product.
 2. Non-Proprietary Specification Requirements: Where the specifications name products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to the use of these products only, the Contractor may, at his option, use any available product that complies with the Contract requirements.
 3. Descriptive Specification Requirements: Where the specifications describe a product or assembly generically, in detail, listing the exact characteristics required, but without use of a brand name, provide products or assemblies that provide the characteristics indicated and otherwise comply with Contract requirements.
 4. Performance Specification Requirements: Where the specifications require compliance with indicated performance requirements, provide products that comply with the specific performance requirements indicated, and that are recommended by the manufacturer for

the application indicated. The manufacturer's recommendations may be contained in published product literature, or by the manufacturer's individual certification of performance. General overall performance of a product is implied where the product is specified for specific performances.

5. Compliance with Standards, Codes, and Regulations: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including standards, codes, and regulations.
 6. Visual Matching: Where matching an established sample is required, the final judgement of whether a product proposed by the Contractor matches the sample satisfactorily will be determined by the Architect. Where there is no product available within the specified product category that matches the sample satisfactorily and also complies with other specified requirements, comply with the provisions of this Section regarding "substitutions" and other Contract Documents for "change orders" for the selection of a matching product in another product category, or for non-compliance with specified requirements.
 7. Visual Selection: Except as otherwise indicated, where specified product requirements include the phrase "...as selected from the manufacturer's standard colors, patterns, textures..." or similar phrases, the Contractor has the option of selecting the product and manufacturer, provided the selection complies with other specified requirements. The Architect is subsequently responsible for selecting the color, pattern and texture from the product line selected by the Contractor.
 8. Allowances: Refer to individual sections of the specifications and Section 01 21 00, Allowances for an indication of product selections that are controlled by established allowances, and for the procedures required for processing such selections.
- D. Producer's Statement of Applicability: Where individual specification sections indicate products that require a "Statement of Applicability" from the manufacturer or other producer, submit a written-certified statement from the producer stating that the producer has reviewed the proposed application of the product on the project. This statement shall state that the producer agrees with or does not object to the Architect/Engineer's specification and the Contractor's selection of the product on the project is suitable and proper.

2.2 SUBSTITUTIONS

- A. Condition: The Contractor's request for substitution will be received and considered when extensive revisions to Contract Documents are not required, when the proposed changes are in keeping with the general intent of the Contract Documents, when the request is timely, fully documented and properly submitted, and when one (1) or more of the above conditions are satisfied, all as judged and determined by the Architect/Engineer; otherwise the requests will be returned without action except to record non-compliance with these requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. General: Except as otherwise indicated in individual sections of these specifications, comply with the manufacturer's instructions and recommendations for installation of the products in the applications indicated.
- B. Anchor each product securely in place, accurately located and aligned with other work.
- C. Clean exposed surfaces and protect surfaces as necessary to ensure freedom from damage and deterioration at time of acceptance.
- D. Products and assemblies shall be installed complete, in-place, watertight and structurally sound.

3.2 INSTALLATION OF APPROVED SUBSTITUTIONS

- A. Coordinate all approved substitutions with adjacent work.
- B. Comply with the manufacturer's and/or supplier's instructions and recommendations for installation of the products in the applications indicated.
- C. Provide all items required by manufacturer and/or supplier regarding installation, i.e. supplemental supports, anchors, fasteners, painting, etc. whether or not indicated or specified.

END OF SECTION 01 25 13

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Work:
 - 1. Section 01 25 13 – Product Substitution Procedures.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 *Architect's Supplemental Instructions*.

1.4 PROPOSAL REQUESTS

- A. Owner Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop Work in progress or to execute the proposed change.
 - 2. After receipt of Proposal Request, submit quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
 - 1. Include statement outlining reasons for the change and the effect of the change on the Work. Provide complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times,

and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Section 01 25 00 if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use AIA Document G709.

1.5 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: When an allowance is specified, refer to Section 01 21 00 for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
 1. Allowance Adjustment: To adjust allowance amounts, base each Change Proposal Request (CPR) on the difference between purchase amount and the allowance, multiplied by final measurement of Work in place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 - a. Include installation costs in purchase amount only where indicated as part of the allowance.
 - b. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 - c. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit cost allowances.
 - d. Owner reserves the right to establish the quantity of Work in place by independent quantity survey, measure, or count.
 2. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 7 days of receipt of the Change Order authorizing work to proceed. Owner will reject claims submitted later than 7 days after authorization.

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Architect will execute a Change Order also requiring signatures of Owner and Contractor on AIA Document G701.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Construction Change Directive contains a complete description of change in the Work and designates the method to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of Work required by the Construction Change Directive. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.
- B. Pencil Copy: A preliminary review copy of the application for payment for review by Architect and Owner prior to submission of final copy.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Updated Submittal schedule.
 - c. Items required to be indicated as separate activities in updated Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment. Contractor's standard form or electronic media printout will be considered but must be approved by the Owner.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703.
 - 3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.

- g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment rentals.
 - 4) General Conditions.
 - a. Supervisor.
 - b. Submittals.
 - c. Close-out.
 - d. Field Engineering.
 - e. Daily Clean-up.
 - f. Final Clean-up.
- 4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
- 5. Provide separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on site and items stored off site. Include evidence of insurance.
- 6. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line item value of unit cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
- 7. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual Work in place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
- 8. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Submit preliminary (pencil) copy of proposed values to Architect or Architects field representative and Owner for review by 20th date of the month. Allow 48 hours for comments.
- B. Once preliminary (pencil) approved, submit electronic copy of notarized originals of each application on AIA Form G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet for G702 or other similar form approved by the Owner.
- C. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.
- D. Submit updated construction or recovery schedule with each Application for Payment.
- E. Payment Period: Submit at intervals stipulated in the Agreement in accordance with Document 00 73 00, Supplementary Conditions of the Contract.
- F. Only materials stored on the project site shall be paid for unless the materials are stored in a bonded warehouse.
- G. Substantiating Data: When Architect/Engineer requires substantiating information, submit data justifying dollar amounts in question. Items which may be requested by the Architect or Owner to substantiate costs include, but are not limited to the following:
 - 1. Current Record Documents as specified in **Section 01 77 00, Closeout Procedures** maintained.

2. Labor time sheets, purchase orders, or similar documentation.
3. Affidavits attesting to off-site stored products.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 29 00

SECTION 01 29 73 - SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. Work Included: Provide a detailed breakdown of the agreed Contract Sum showing values allocated to each of the various parts of the work, as specified herein and in other provisions of the Contract Documents.
- B. Coordinate requirements of this Section with the requirements of the General and Supplementary Conditions of the Contract concerning Schedule of Values.

1.3 QUALITY ASSURANCE

- A. Use required means to assure arithmetical accuracy of the sums described.
- B. When so required by the Owner, provide copies of the subcontracts or other data acceptable to the Owner, substantiating the sums described.

1.4 SUBMITTALS

- A. Prior to the first Application for Payment, submit a proposed schedule of values to the Owner, as outlined below:
 - 1. Meet with the Owner and determine additional data, if any, required to be submitted.
 - 2. Secure the Owner's approval of the schedule of values prior to submitting first Application for Payment.

1.5 SCHEDULE OF VALUES

- A. The Schedule of Values shall be broken down into item costs for each specification section as a minimum. After review by the Owner, the Schedule of Values shall be broken down into further items as required. (See following list and refer to the enclosed sample.). In addition, total each Specification Division separately.
- B. Schedule of Values - Items in addition to Specification Sections.
 - 1. Mobilization
 - 2. Clean Up
 - 3. Building Permit
 - 4. Bonds, Insurance
 - 5. Misc. Mechanical Accessories
 - 6. Demolition
 - 7. Rough-In Labor - (Electrical)
 - 8. Rough-In Material - (Electrical)
 - 9. Finish Labor - (Electrical)
 - 10. Finish Material - (Electrical)
 - 11. Allowances (listed separately)
 - 12. Record drawings and close-out documents
 - 13. Submittals listed separately per mechanical, electrical and plumbing
 - 14. Roof warranty as a line item

15. Donated items individually itemized at \$0.00 (zero dollars).

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 SCHEDULE OF VALUES

- A. Refer to following sample.

END OF SECTION 01 29 73

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|--|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Div. 1 - General Reqs. Site Work General Conditions Supervision Mobilization Bonds & Insurance Permits Contractor's Fee Close-Out Documents | | | | | | | | |
| | Div. 1 - Total | | | | | | | | |
| | Div. 2 - Existing Conditions Demolition (As applicable) Erosion Control Div. 2 - Total | | | | | | | | |
| | Div. 3 - Concrete Drill Piers Caps & Beams Slab on Grade Cooling Tower Basin Misc Bldg Conc Floor Sealer Rebar Matl Rebar Labor Lt.Wt.Insul Fill - Materials Lt.Wt.Insul Fill - Labor Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 3 - Total Div 4 - Masonry Brickwork - Labor Brickwork - Matls Concrete Masonry - Labor Concrete Masonry - Materials Str. Glazed Tile-Labor Str. Glazed Tile-Materials Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 4 - Total | | | | | | | | |
| | Div 5 - Metals Structural Steel - Labor Structural Steel - Materials Alternating Stairs Misc. Steel - Materials Steel Joists - Materials Lt. Gauge Steel Framing-Labor Lt. Gauge Steel Framing-Matls Metal Decking - Labor Expansion Joint Covers Metal Decking - Matls | | | | | | | | |

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|--|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Detailing Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 5 - Total | | | | | | | | |
| | Div. 6 - Wood & Plastics Rough Carpentry - Labor Rough Carpentry - Materials Millwork - Labor Millwork - Materials Submittals/Close-Out Documents | | | | | | | | |
| | Div. 6 - Total | | | | | | | | |
| | Div. 7 - Thermal and Moisture Protection Waterpfng / Dampprfng-Matls Waterpfng / Dampprfng-Labor Building Insulation - Labor Building Insulation - Materials Fireproofing - Labor Fireproofing - Materials Metal Roof - Labor Metal Roof - Materials Metal Roof Guarantee Built-up Roofing-Labor Built-up Roofing-Materials Built-up Roofing Guarantee Roof Accessories Building Sheet Metal - Labor Building Sheet Metal - Matls Bldg. Sheet Metal Guarantee Roof Curbs Roof Hatches Sealants Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 7 - Total | | | | | | | | |
| | Div. 8 - Doors and Frames Finish Carpentry/Door - Labor Finish Hardware - Matls Thresholds & Seals - Matls+B66 Hollow Metal Doors & Frames - Matls Plastic Faced Doors-Matls Overhead Doors & Grilles-Labor Overhead Doors & Grilles - Matls Alum. Entrances & Store-fronts - Labor Alum. Entrances & Store- | | | | | | | | |

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|---|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | fronts - Matls Alum. Windows - Labor Alum Windows - Matls Glass & Glazing-Labor Glass & Glazing-Matls Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 8 - Total | | | | | | | | |
| | Div. 9 - Finishes Lath & Plaster-Labor Lath & Plaster-Matls Gypsum Wallboard Systems - Labor Gypsum Wallboard Systems - Matls Ceramic Tile - Labor Ceramic Tile - Matls Quarry Tile - Labor Quarry Tile - Matls Terrazzo-Labor Terrazzo-Matls Acoustic Clg. - Labor Acoustic Clg. - Matls Acoustic Wall Panels Resilient Flooring - Labor Resilient Flooring - Matls Carpet - Labor Carpet - Matls Athletic Flooring - Materials Athletic Flooring - Labor Floor Sealer Painting - Labor Painting - Mtls Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 9 - Total | | | | | | | | |
| | Div. 10 - Specialties Visual Display Boards & Tackboards - Materials Visual Display Boards & Tackboards - Labor Toilet Partitions - Labor Toilet Partitions - Matls Louvers Aluminum Flag Pole Graphics Lockers Cubicle Curtains & Track Fire Extinguisher Cabinets Demountable Partitions-Labor | | | | | | | | |

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|---|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Demountable Partitions-Matls Shelving Toilet Room Accessories-Matls Toilet Room Accessories-Lbr Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 10 - Total | | | | | | | | |
| | Div. 11 - Equipment Stage Curtains Misc. Appliances Food Service Eqpt-Labor Food Service Eqpt-Matls Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 11 - Total | | | | | | | | |
| | Div. 12 - Furnishings Horizontal Blinds Projection Screens Casework - Labor Casework - Matls Science Casework - Labor Science Casework - Matls Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 12 - Total | | | | | | | | |
| | Div. 13 - Specialties Stage Curtains and Draperies Music Instrument Storage Bleachers Press Box Pre-eng. Metal Bldg. Stadium Seating Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 13 - Total | | | | | | | | |
| | Div. 14 - Conveying Systems Platform Lifts Elevators Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 14 - Total | | | | | | | | |
| | Div. 21, 22 - Plumbing Shop Drawings As-Builts/Close-Out/ O&M Manuals Sanitary Underground - | | | | | | | | |

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|---|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Labor Sanitary Underground - Matls Storm Underground - Labor Storm Underground - Matls Domestic Water - Labor Domestic Water - Matls Plumbing Insulation - Matls Plumbing Insulation - Labor Gas Piping - Matls Gas Piping - Labor Grease Trap Plumbing Fixtures - Matls Plumbing Fixtures - Labor Coordination Drawings Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 21, 22 Plumbing - Total | | | | | | | | |
| | Div. 23 - Mechanical Shop Drawings As-Builts/Close-Out/ O&M Manuals Chillers - Matls Chillers - Labor Cooling Towers - Matls Cooling Towers - Labor Boilers - Matls Boilers - Labor AHU's - Matls AHU's - Labor Fans - Matls Fans - Labor Grilles - Matls Grilles - Labor Ductwork - Matls Ductwork - Labor Pumps - Mtls Pumps - Labor Water Treatment - Labor Water Treatment - Matls Isolation - Labor Isolation - Matls Pipe Flex - Matls Pipe Flex - Labor Connections Sheet Metal - Matls Sheet Metal - Labor Duct Insulation - Matls Duct Insulation - Labor | | | | | | | | |

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|--|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Pipe Insulation - Matls Pipe Insulation - Labor VAV Boxes - Materials VAV Boxes - Labor Refrigerant Monitor - Matls Refrigerant Monitor - Labor Unit Heaters - Materials Unit Heaters - Labor Startup Controls - Matls Control - Labor Engineer / Submittals Modules / End Devices Low Voltage Wiring Startup Close-Out Documents Fire Sprinkler Engineer / Submittals Piping - Materials Piping - Labor Equipment - Materials Equipment - Labor Trimout - Materials Trimout - Labor Pipe, Valves, Fittings - Labor Pipe, Valves, Fittings - Matls Misc. - Matls Insulation - Matls Insulation - Labor Sanitary Above Slab-Labor Sanitary Above Slab-Matls Storm Above Slab - Labor Storm Above Slab - Matls Gas - Labor Gas - Matls Fixtures - Labor Fixtures - Matls Permits Coordination Drawings Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 23 Mechanical - Total | | | | | | | | |
| | Div. 26 - Electrical | | | | | | | | |
| | Mobilization+B220 Shop Drawings As-Builts/Close-Out/ O&M Manuals Underground Conduit - Labor Conduit - Matl Wire - Labor | | | | | | | | |

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|---|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Wire - Matls Feeder Wire - Labor Feeder Wire - Matls Switches/Recpt. Switchgear - Labor Switchgear - Matls Temporary - Materials Temporary - Labor Gas Generator - Materials Gas Generator - Labor Fixtures - Labor Fixtures - Matls Communications - Labor Communications - Matls Fire Alarm - Labor Fire Alarm - Matls Security - Labor Security - Matls Low Voltage Ltng Sys-Matls Low Voltage Ltng Sys-Labor Voice System - Materials Voice System - Labor Video System - Materials Video System - Labor Data System - Materials Data System - Labor Master Clock - Materials Master Clock - Labor+B277 Coordination Drawings Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 26 - Total | | | | | | | | |
| | Divs. 31, 32 and 33 - Earthwork, Exterior Improvements and Utilities | | | | | | | | |
| | Site Clearing & Grubbing Building Pad - Materials Building Pad - Labor Paving Subgrade Signage / Striping Bike Racks Landscaping - Materials Landscaping - Labor Hydro Mulch - Materials Hydro Mulch - Labor Irrigation - Materials Irrigation - Labor Earthwork Finish Grading Stabilization - Materials Stabilization - Labor Site Drainage - Materials Site Drainage - Labor | | | | | | | | |

SCHEDULE OF VALUES - SAMPLE

01 29 73

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

| Item No. | Description of Work | Scheduled Value | Work Completed | | Stored Materials | Total Completed | % | Balance To Finish | Retainage |
|----------|---|-----------------|----------------|-----------|------------------|-----------------|---|-------------------|-----------|
| | | | Previous App. | This App. | | | | | |
| | Chain Link Fence-Materials Chain Link Fence-Labor Paving - Labor Paving - Materials Sidewalks Submittals/Close-Out Documents Supervision Clean-up | | | | | | | | |
| | Div. 31, 32 and 33 - Total | | | | | | | | |
| | General Conditions Mobilization Temp. Facilities Final Cleaning Record Documents/Close-out/ O&M Manuals Supervision Permits Bonds Insurance Allowances Alternates (list) Change Orders A. PR# B. PR# C. PR# | | | | | | | | |

END OF SECTION

SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Pre-install meetings.
- B. Each Contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific Contractor.
- C. Contractor shall make a reasonable attempt to interpret the Contract Documents before asking the Architect for assistance in interpretation. Requests for Information (RFI's) will not be allowed from the Contractor. The Contractor shall arrange the necessary meeting in the field with appropriate Architect's field representative(s) to obtain clarification as needed on items that may need interpretation.

1.3 SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.4 COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.

- B. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate Contractors if coordination of the Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.
 - 9. Coordinating inspections and other jurisdictional requirements.
 - 10. Coordinate OFCI equipment.
 - 11. Action items and issue logs.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to the Specifications Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 - 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade specific information to the coordination drawings by multiple Contractors in sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.

- d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings:
1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures, ductwork, piping, and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches (32 mm) in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 - e. Floor boxes.
 8. Fire Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, sprinkler heads, and inspector test locations.
 9. IDF/MDF Rooms: Communications and low voltage (security, data, phone, etc.) audio
 10. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make changes as directed and resubmit.

11. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 3. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in Revit.
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.6 PROJECT MEETINGS

- A. Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Architect to prepare the meeting agenda and distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
 4. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
 5. Issue logs: Documentation element of software project management and contains a list of ongoing and closed issues of the project.
- B. Kick-off & Preconstruction Conference: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect.
 1. Conduct the conference to review responsibilities and personnel assignments.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that affect progress.
 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- C. Preinstallation Conferences: Conduct a preinstallation trade conference at site before each construction activity that requires coordination with other construction trades.
 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Engineer of Record of scheduled meeting dates.
 2. Agenda: Contractor to review progress of other construction activities and preparations for the particular activity under consideration.
 3. Contractor to record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Contractor to distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
 6. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Substantial Completion.
 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- E. Progress Meetings: Conduct progress meetings at weekly intervals.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner and Architect, each Contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
 - b. Six (6) week look-ahead schedules.
 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- F. Coordination Meetings: Conduct coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

- a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each Contractor present.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.
4. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup construction schedule.
 - 2. Contractor's construction schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Site condition reports.
 - 7. Special reports.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Resource Loading: The allocation of manpower and equipment necessary for completion of an activity as scheduled.
- G. Recovery Schedule: Submittal of a revised critical path method (CPM) schedule and a written plan.
- H. Look-ahead Schedule: Prepare schedule indicating activities scheduled to occur or commence prior to submittal of next schedule update.

- I. Milestones: Measurable and observable and serve as progress markers (flags) but, by definition, are independent of time (have zero durations) therefore no Work or consumption of resources is associated with them.

1.4 SUBMITTALS

- A. Submittal Format: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic file.
- B. Startup Diagram: Of size necessary to display entire network for entire construction period. Show logic relationship ties for all activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Daily Construction Reports: Submit at monthly intervals.
- G. Material Location Reports: Submit at monthly intervals.
- H. Site Condition Reports: Submit at time of discovery of differing conditions.
- I. Special Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at site. Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including phasing, Work stages, area separations, interim milestones, and partial Owner occupancy.
 - 4. Review delivery dates for Owner furnished products.
 - 5. Review schedule for Work of Owner's separate contracts, if any.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Time is of the essence to the Owner. Commence Work immediately upon issuance of the Notice to Proceed. There is a critical need for the Work to be substantially complete within the time frame identified in the Agreement.
- B. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion and date of final completion.
 - 1. Contract completion date shall not be changed by submission of schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each separate area or story as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities in terms of number of days anticipated.
 - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 - 4. Startup and Testing Time: Include number of days anticipated for startup and testing.
 - 5. Substantial Completion: Indicate completion of all conditions as in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 - 6. Punch List and Final Completion: Include a maximum of 30 days for completion of punch list items and final completion.
 - 7. Inspections required by Authorities Having Jurisdiction (AHJ).
- D. Constraints: Include constraints and Work restrictions indicated in the Contract Documents and show how the sequence of the Work is affected.
 - 1. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 - i. Rain days as indicated in Specification Section 01 10 00 Summary.

2. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Submittals.
 - b. Mockups.
 - c. Fabrication.
 - d. Installation.
 - e. Tests and inspections.
 - f. Adjusting.
 - g. Curing.
- E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
- F. Six (6) week, lookahead schedule: Prepare schedule indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
 6. Inspections by Authorities Having Jurisdiction (AHJ).
 7. Trade pre-installation conference.
- G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- I. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time impact analysis to demonstrate the effect of the proposed change on the overall project schedule.
- J. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.

2.2 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording information concerning events at the site and submit each month to Architect:
 1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Rental equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).

10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of Authorities Having Jurisdiction (AHJ).
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report and contact Architect Field Representative. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents to Architect Field Representative.
- D. Special Reports: Submit special reports directly to Owner within 24 hours of an occurrence. Distribute copies of report to parties affected by the occurrence.
1. Reporting Unusual Events: When an event of an unusual and significant nature occurs at site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner & Architect in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule with a pencil copy of pay application.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and interested parties identified by Contractor with a need to know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final completion construction photographs.

1.3 SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph or video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Digital Camera: Minimum sensor resolution of 8 megapixels.
 - 2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
 - 3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- C. Construction Photographs: Submit two prints of each photographic view within seven days of taking photographs.
 - 1. Format: 8 inch by 10 inch (203 mm by 254 mm) smooth surface matte prints on single weight, commercial grade photographic paper; mounted on card stock to allow a 1 inch (25 mm) wide margin punched for standard three-ring binder.
 - 2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken if not date stamped by camera.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.5 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image editing software.
 - 1. Date and Time: Include date and time in file name for each image.
 - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- C. Preconstruction Photographs: Before commencement of the Work, take photographs of site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag construction limits before taking construction photographs.
 - 2. Take minimum of 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take minimum of 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Periodic Construction Photographs: Take minimum of 20 photographs monthly, coinciding with cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
 - 1. Take photographs as evidence of existing project conditions as follows:
 - a. Site: Take four (4) site aerial photographs at project corners.
 - b. Interior views: Take four (4) minimum interior photographs of each space under construction from differing directions or as required.
 - c. Exterior views: Take two (2) photographs of each elevation.
 - d. Details: Take as required to document concealed conditions, including, but not limited to, underground construction, utility penetrations and installation, steel erection, concrete and masonry reinforcing, waterproofing and flashing, and roofing installation.

- E. Architect Directed Construction Photographs: From time to time, Architect will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.
- F. Time Lapse Sequence Construction Photographs: Take minimum of 20 photographs as indicated, to show status of construction and progress since last photographs were taken.
 - 1. Frequency: Take photographs monthly, coinciding with the cutoff date associated with each Application for Payment.
 - 2. Vantage Points: Following suggestions by Architect and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than two of the required shots from same vantage point each time to create a time lapse sequence.
 - a. Commencement of the Work, through completion of subgrade construction.
 - b. Above grade structural framing.
 - c. Exterior building enclosure.
 - d. Interior Work, through date of Substantial Completion.
- G. Final Completion Construction Photographs: Take minimum of 20 color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.
 - 1. Do not include date stamp.
- H. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow up when on site events result in construction damage or losses.
 - c. Take photographs at fabrication locations away from site.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS

- A. Submittals: Written and graphic information and physical samples that require Architect's responsive action or are for information and do not require the architect's action.
- B. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- C. Portable Document Format (PDF): An open standard file format used for representing documents in a device independent and display resolution independent fixed layout document format.

1.4 SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal: Submit concurrently with construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.
 - 1. Upon request, Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.
 - a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in Revit.
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106, Digital Data Licensing Agreement.
 - d. The following digital data files will be furnished for each appropriate discipline:

- 1) Floor plans.
 - 2) Reflected ceiling plans.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow ten (10) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process in same manner as initial submittal.
 3. Resubmittal Review: Allow ten (10) days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow ten (10) days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 3. Transmittal Form for Electronic Submittals: Use software generated form from electronic project management software acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.

- n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number, numbered consecutively.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
- 4. Metadata: Include the following information as keywords in the electronic submittal file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. Options: Identify options requiring selection by Architect.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 - OR**
 - 2. Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.
 - 3. Certificates and Certifications Submittals: Provide statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 5. Submit Product Data before or concurrent with Samples.
 - 6. Submit Product Data in PDF electronic file.
- C. Shop Drawings: Prepare Project specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 - 2. Sheet Size: Except for templates, patterns, and similar full size drawings, submit Shop Drawings on sheet size indicated in specification section.
 - 3. Submit Shop Drawings in PDF electronic file.
 - 4. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.
 - a. Prepare Shop Drawings in same digital data software program, version, and operating system as the original Drawings.
 - b. Refer to Section 01 31 00 for requirements for coordination drawings.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.

- d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
- 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
- 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- 5. Samples: Submit full size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Key Items Review Time: Submit samples to the Architect at least 30 days prior to the date the Contractor needs the reviewed submittals returned. The Contractor shall be prepared to submit color samples on any key items in Division 09 finishes within 30 days of the award of Contract. Once samples of all key items are received, the Architect will finalize color selections.
 - b. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 - 2. Manufacturer and product name, and model number if applicable.
 - 3. Number and name of room or space.
 - 4. Location within room or space.
 - 5. Submit product schedule in PDF electronic file.
- F. Coordination Drawing Submittals: Comply with requirements specified in Division 01.
- G. Contractor's Construction Schedule: Comply with requirements specified in Division 01.
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00.
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00.

- J. Closeout Submittals required for Substantial Completion: Comply with requirements specified in Section 01 77 00.
- K. Maintenance Data: Comply with requirements specified in Section 01 78 23.
- L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

- W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and required submittals, submit digitally signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM File Incorporation: Incorporate delegated design drawing and data files into Building Information Model established for Project.
 - 1. Prepare delegated design drawings in the same digital data software program, version, and operating system as the original Drawings.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- C. Incomplete submittals are not permitted, will be considered nonresponsive, and will be returned for resubmittal without review.
- D. Submittals not required by the Contract Documents will be returned by the Architect without action.

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

- A. Quality Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Laboratory Mockups: Full size physical assemblies constructed at testing facility to verify performance characteristics.
 - 2. Integrated Exterior Mockups: Mockups of exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
 - 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality Control Testing: Tests and inspections performed on site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform particular construction operations, including installation, erection, application, and similar operations.
 - 1. Use of trade specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, *experienced* means having successfully completed a minimum of five years documented experience with projects similar in nature, size, and extent; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

- A. Shop Drawings: Submit plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting Work on the following systems:
 - 1. Seismic force resisting system, designated seismic system, or component listed in the designated seismic system quality assurance plan prepared by Architect.
 - 2. Main wind force resisting system or wind resisting component listed in the wind force resisting system quality assurance plan prepared by Architect.
- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.

4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality control service.

1.6 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
 1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory authorized service representative's tests and inspections specified in other Sections. Include the following:
 1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.
- E. Trade Preinstallation Conferences: Meeting minutes to be Contractor provided.

1.7 QUALITY ASSURANCE

- A. Qualifications establish the minimum qualification levels required; refer to individual Specification Sections for additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated and sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated and with record of successful in service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling Work similar in material, design, and extent to that indicated for this Project, whose Work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Texas, experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products.
- I. Factory Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit certified written report of each test, inspection, and similar quality assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 2. Notify Architect a minimum of seven days in advance of dates and times when mockups will be constructed.
 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction.
 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 5. Obtain Architect's approval of mockups before starting Work, fabrication, or construction. Allow **seven** days for initial review and each re-review of each mockup.
 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 7. Demolish and remove mockups when directed unless otherwise indicated.
- L. Integrated Exterior Mockups: Mockup of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies shall be constructed. Mockup, if not specifically shown on the drawings, shall be minimum 8'x8'. Mockup shall include all major façade elements and at least one window minimum 2'x2' in size. Prior to constructing mockup verify requirements with architect. Pre-installation conferences for trades involved in Integrated Exterior Mockup shall be held after mock up is completed.
- M. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.
- N. Trade Preinstallation Conferences: Meeting minutes to be Contractor provided.

1.8 QUALITY CONTROL

- A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
 1. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.

5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory authorized service representative to inspect field assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300.
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.9 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner:
- B. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections.
 1. Verifying that manufacturer maintains detailed fabrication and quality control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality control service to Architect with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00.
- B. Protect construction exposed by or for quality control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK REQUIREMENTS

- A. General: This Section specifies procedural and administrative requirements for compliance with governing regulations and codes and standards imposed upon the Work. These requirements include the obtaining of permits, licenses, inspections, releases, and similar statements, as well as payments, associated with regulations, codes, and standards.
- B. "Regulations" is defined to include laws, statutes, ordinances, and lawful orders issued by governing authorities, as well as those rules, conventions and agreements within the construction industry which effectively control the performance of the Work regardless of whether they are lawfully imposed by governing authority or not.
- C. Governing Regulations: Refer to General and Supplementary Conditions for requirements related to compliance with governing regulations.

1.3 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized", "selected", "required", and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown", "noted", "scheduled", and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

- J. "Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.4 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference. Individual Specification Sections indicate which codes and standards the Contractor must keep available at the project site for reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and where these standards establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents specifically indicate a less stringent requirement. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Architect/Engineer for a decision before proceeding.
- D. Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified is intended to be the minimum for the Work to be provided or performed. Unless otherwise indicated, the actual Work may either comply exactly, within specified tolerances, with the minimum quantity or quality specified, or may exceed that minimum within reasonable limits. In complying with these requirements, the indicated numeric values are either minimum or maximum values, as noted, or as appropriate for context of the requirements. Refer instances of uncertainty to the Architect/Engineer for decision before proceeding.

1.5 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the trade association, standards-producing organization, authorities having jurisdiction or other entity applicable to the context of the text provision.
- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the Agency.
- C. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations.

1.6 SUBMITTALS

- A. Permits, Licenses and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS

Not Used

PBK Sports
Project No. 18309SP

PSJA ISD New Swimming Facilities
Pharr-San Juan-Alamo Independent School District

PART 3 - EXECUTION

Not Used

END OF SECTION 01 42 00

01 45 23 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

- 1.1.1. Specifications throughout all Divisions of the Project Manual, which pertain to operable and non-operable equipment and/or building systems, are directly applicable to this Section, and this Section is directly applicable to them.

1.2. SUMMARY

- 1.2.1. This Section establishes general and administrative requirements pertaining to commissioning of equipment, devices, and building systems on the project. Technical requirements for commissioning of particular systems and components are established in the respective technical sections of this Project Manual.
- 1.2.2. It is of primary concern that all operable systems installed in the Project perform in accordance with the Contract Documents, the Owner's Project Requirements (OPR) and the Basis of Design (BOD). During Commissioning, the Contractor systematically demonstrates to the Owner or Owner's representative that the operable systems have been installed and performing in strict accordance with the Contract Documents.
- 1.2.3. Commissioning requires cooperation and involvement of all parties throughout the construction process. The Contractor shall deliver a successful Commissioning process. Successful Commissioning requires that installation of all building systems complies with Contract Document requirements and that full operational check-out and necessary adjustments are performed prior to Substantial Completion with the exception of Deferred tests approved in advance by the Owner.
- 1.2.4. Commissioning will encompass and coordinate traditionally separate functions of system documentation, installation checkout, System Verification Checklists and start-up, control system calibration and point-to-point checkout, testing, adjusting, and balancing, Functional Performance Tests, Integrated System Tests, Contractor demonstration to the Owner, and training of Owner's personnel. This requires assembling all related documentation into one cohesive collection. Commissioning is intended to achieve the following specific objectives of the Contract Documents:
 - 1.2.4.1. Verify and document proper installation and intended performance of equipment, systems, and integrated systems.
 - 1.2.4.2. Ensure that operating and maintenance and Commissioning documentation requirements are complete.
 - 1.2.4.3. Provide the Owner with functional buildings and systems that meet the Contract Document requirements and the Owner's Project Requirements (OPR) at Substantial Completion.

1.3. DEFINITIONS

- 1.3.1. Basis of Design (BOD): A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements and to satisfy applicable regulatory requirements, standards and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- 1.3.2. Commissioning (Cx): A systematic process confirming that building systems have been installed, properly started, and consistently operated in strict accordance with the Project Documents, that

all systems are complete and functioning in accordance with the Contract Documents at Substantial Completion, and the Contractor has provided the Owner adequate system documentation and training.

- 1.3.3. Commissioning Authority (CxA): Party having a contractual agreement with the Owner to provide third party commissioning services as defined herein under Commissioning Authority's Role and Responsibilities. Commissioning Authority may represent the Owner and is authorized to act on behalf of the Owner. The Commissioning Authority does not have authority to alter design or installation procedures without the written approval of the Owner or the design team.
- 1.3.4. Contract Documents: The General Conditions, Drawings, Specifications, Addenda, and other documents developed by the A/E Team and approved by the Owner that constitute the contractual obligations of the project scope.
- 1.3.5. Control Point and Sensor Calibration Verification: Process of verifying the point integrity and/or sensor calibration from the physical point of monitoring (sensor, contact, actuator, etc.) to the digital point location at the Operator's interface within the respective control system (Building Automation, Lighting Controls, Power Status and Monitoring, etc.).
- 1.3.6. Deferred Testing: Functional Performance or Integrated System Tests performed after Substantial Completion due to partial occupancy, partial equipment acceptance, seasonal requirements, design, or other site conditions that prohibit the test from being performed prior to Substantial Completion.
- 1.3.7. Deficiency: Condition of a component, piece of equipment, or system that is not in compliance with the Project Documents.
- 1.3.8. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems executed by the Contractor and witnessed by the CxA. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are operated through all specified sequences of operation. Components are verified to be responding in accordance with requirements in the Project Documents.
- 1.3.9. Functional Performance Testing Procedures: Commissioning protocols, detailed test procedures and instructions in tabular and script-type format that fully describe system configuration and steps required to determine if the system is performing and functioning properly.
- 1.3.10. Integrated Systems Test (IST): Test of dynamic function and operation of multiple systems. Integrated Systems Tests are tested under various modes, such as fire alarm and emergency situations, life safety conditions, power failure, etc. Systems are integrally operated through all specified sequences of operation. Systems and interconnections are verified to be responding in accordance with the requirements in the Project Documents.
- 1.3.11. Integrated Systems Testing Procedures: Commissioning protocols and detailed test procedures and instructions in tabular and script-type format that fully describe system configurations and steps required to determine if the interacting systems are performing and functioning properly.
- 1.3.12. Operational Testing: Activities and testing occurring after initial energizing and/or start-up of equipment that determine whether equipment is operating within the manufacturer's recommendations and the design requirements. These activities are intended to ensure that equipment and systems meet all warranty requirements and are ready for Functional Performance Testing. Common examples are Testing, Adjusting and Balancing of HVAC systems and initial load testing of electrical equipment.

- 1.3.13. Owner's Project Requirements (OPR): A written document that details the functional requirements of a project and the expectations of how the facility will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria and supporting information.
- 1.3.14. Project Documents: Consists of the Contract Documents, Approved Submittals, Requests for Information (RFI), Vendor documentation, Operations and Maintenance (O&M) information and other documentation that determines the requirements for acceptable installation and operation of the specific equipment and systems on the project.
- 1.3.15. System Verification Checklist (SVC): A list of static inspections and material or component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gages in place, sensors calibrated, etc.), start-up activities and documentation, as well as operational testing results. The checklists are meant to document all activities for an individual piece of equipment from procurement on the project through operational testing are performed in accordance with the requirements in the project documents.
- 1.3.16. Start-up: The activities where equipment is initially energized, tested and operated. Start-up is completed prior to Operational Testing and Functional Performance Testing and is an integral item documented in the System Verification Checklist (SVC).
- 1.3.17. Training Plan: A detailed plan prepared by the Contractor and reviewed by the Owner and Commissioning Authority that outlines the training activities, instructors, time durations, and system requirements in accordance with the Contract Documents and Commissioning Plan.
- 1.3.18. Trending: Data collection of monitored points using the Building Automation System, Lighting Controls System, Power Status and Monitoring System or independent data acquisition instrumentation.

1.4. COMMISSIONING TEAM

1.4.1. Owner shall appoint the following Members:

- 1.4.1.1. Owner's Project Manager and any other designated representatives of the Owner's staff.
- 1.4.1.2. Commissioning Authority (CxA)
- 1.4.1.3. Architect/Engineer (A/E)
- 1.4.1.4. Test, Adjust and Balance Firm (TAB) – may be sub-contracted to the CxA

1.4.2. Contractor shall appoint the following Members:

- 1.4.2.1. Individuals, each having authority to act on behalf of the entity they represent, explicitly organized to implement the Commissioning process through coordinated actions. At a minimum, the Contractor shall designate a Commissioning Coordinator and each major sub-contractor (Mechanical, Electrical, Plumbing, Building Automation) shall have a dedicated representative.
- 1.4.2.2. Vendor representatives (as needed) required for start-up, operational testing, Functional Performance Testing, Integrated Systems Testing, and Owner Training activities.
- 1.4.2.3. Representatives of independent testing agencies (Test, Adjust and Balance, Electrical Testing Agency, etc.)

GENERAL COMMISSIONING REQUIREMENTS

1.5. ROLES AND RESPONSIBILITIES

1.5.1. Roles and responsibilities of Commissioning Team members related to the Commissioning Process are provided in this Section. The respective entities defined below shall fulfill the listed roles and responsibilities as contained herein. Specific technical roles and responsibilities are defined in other sections of the Project Specifications.

1.5.2. Owner's Roles and Responsibilities:

1.5.2.1. Provide guidance in development of the Owner's Project Requirements (OPR).

1.5.2.2. Review Technical Specifications containing Commissioning requirements.

1.5.2.3. Approve the Commissioning Scope of Work and schedule of Commissioning activities.

1.5.2.4. Assign Owner's representatives and schedule them to participate in Commissioning activities, including the following:

1.5.2.4.1. Commissioning Team meetings.

1.5.2.4.2. Review and approval of the Commissioning Plan, Training Plan, System Verification Checklist templates, Functional Performance Test Procedures, Integrated Systems Test Procedures, Deferred Testing Plans, Final Commissioning Process Report, Systems Manual, Measurement and Verification Plan and other Commissioning documents.

1.5.2.4.3. Attend Owner Training sessions in operation and maintenance of systems and equipment.

1.5.2.4.4. Observation of Contractor's demonstration of systems and equipment operation.

1.5.3. Commissioning Authority's (CxA) Roles and Responsibilities:

1.5.3.1. Prepare the Commissioning Plan with the Owner's and Contractor's review and input.

1.5.3.2. Periodically attend and/or review the proceedings of the regular Construction Meetings hosted by the Contractor to understand the progress of construction activities on the project.

1.5.3.3. Conduct and document Commissioning Team meetings including the Commissioning Kickoff Meeting.

1.5.3.4. Perform site visits as necessary to observe component and system installations prior to energizing or start-up of equipment and systems.

1.5.3.5. Review and comment on product data and shop drawing submittals and coordination drawings applicable to systems being commissioned.

1.5.3.6. Following submittal review and approvals by the A/E team, review the sequences of operation and coordinate with the Contractor and A/E Team in order to prepare the Functional Performance Test Procedures and Integrated Systems Test procedures. Submit to the Owner and Contractor for review and comment prior to facilitating FPTs and ISTs on the project.

GENERAL COMMISSIONING REQUIREMENTS

- 1.5.3.7. Upon written notice that equipment or systems are ready for initial energizing or start-up, review the progress of the System Verification Checklist(s) for the respective systems and components and ensure that all requirements have been completed by the Contractor to permit energizing or start-up in accordance with the project documents; CxA shall issue written notice to the Owner and Contractor that equipment is ready to energize or start-up. CxA will witness and ensure proper documentation is provided by the Contractor for major equipment energizing and start-ups as executed by the Contractor with appropriate notice as indicated herein.
- 1.5.3.8. Witness, verify, and document results of Functional Performance Tests and Integrated Systems Tests.
- 1.5.3.9. Coordinate resolution of deficiencies identified during site observations, equipment energizing or start-up, Functional Performance Testing, Integrated Systems Testing, Deferred Testing, and during the warranty period.
- 1.5.3.10. Review the Operating and Maintenance (O&M) documents to ensure that as-built information and correct data is included prior to the Owner Training sessions; review final O&M submittal to ensure compliance with the requirements in the project documents and provide written comments to the Owner.
- 1.5.3.11. Review the Contractor's Training Plan and individual training agendas for compliance with the requirements in the project documents. Recommend acceptance to the Owner prior to the Contractor scheduling training sessions with the Owner. Review the attendance and content of the training sessions to ensure the requirements of the project documents are completed. Conduct a survey of the Owner's personnel to evaluate the effectiveness of the Owner Training.
- 1.5.3.12. Compile the Final Commissioning Process Report and submit to the Owner for review and approval.
- 1.5.4. Architect/Engineer's (A/E) Roles and Responsibilities:
 - 1.5.4.1. Specify control sequences of operation within the Contract Documents that comply with the OPR and BOD.
 - 1.5.4.2. Incorporate Commissioning requirements into the Contract Documents if requested by the Owner.
 - 1.5.4.3. Attend Commissioning Team meetings.
 - 1.5.4.4. Review the Commissioning Plan, System Verification Checklist templates, Functional Performance Test Procedures, Integrated Systems Test Procedures, Deferred Testing Plans, and other Commissioning documents as required by the Owner or the Contract Documents.
 - 1.5.4.5. Review Contractor's Training Plan and provide comments to the Owner.
 - 1.5.4.6. Approve technical requirements for correction of Deficiencies identified during Commissioning, Deferred Tests, and during the warranty period.
 - 1.5.4.7. Review Operating and Maintenance Manuals and provide comments to the Owner.
- 1.5.5. Contractor's Roles and Responsibilities:

- 1.5.5.1. Contractor shall review and provide comments on documents produced by the Commissioning Authority, and shall accept the Commissioning Plan, System Verification Checklists, Functional Performance Test Procedures, and Integrated System Test Procedures as approved by the Owner.
- 1.5.5.2. Provide an individual, subject to the Owner's approval, experienced in construction and Commissioning of building systems to organize, schedule, conduct, and document the Contractor's responsibilities in the Commissioning process. The Contractor shall assign this individual to act as the Contractor's Commissioning Coordinator. The Contractor's Commissioning Coordinator may have additional duties such as MEP Coordinator, but not as Project Manager or Superintendent. Submit qualifications demonstrating the Commissioning Coordinator's technical expertise and experience to the Owner for approval. In the event that Contractor chooses to subcontract its Commissioning obligations, then Contractor must submit the subcontractor's qualifications and personnel to Owner for Owner's approval.
- 1.5.5.3. Furnish and install systems that meet all requirements of the Contract Documents.
- 1.5.5.4. Ensure that Commissioning Process activities are incorporated into the Master Project Schedule. The Contractor shall coordinate with the CxA and the Owner to determine the required activities, durations and predecessors.
- 1.5.5.5. Submit inspection requests, start-up requests and all supporting documentation in accordance with the Contract Documents, General Conditions, and Commissioning Plan.
- 1.5.5.6. Cooperate with Owner's representative(s), provide access to work and provide adequate labor, resources, and time for Commissioning.
- 1.5.5.7. Furnish copies of all shop drawings and submittals, manufacturers' literature, maintenance information, and any other information required for the Commissioning process. Contractor must submit to the Owner installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by the factory or field technicians. This requirement does not supersede any additional requirements contained in the Contract Documents.
- 1.5.5.8. Schedule and conduct pre-installation meetings and pre-commissioning meetings with subcontractors and equipment suppliers related to Commissioning. Contractor must invite Architect/Engineer, Owner and CxA to attend the pre-installation meetings and pre-commissioning meetings.
- 1.5.5.9. Provide qualified personnel, including subcontractors as required, to fully perform the testing and operational demonstrations required by the Contract Documents and the Commissioning Plan, including any Deferred Testing or re-testing related to warranty work.
- 1.5.5.10. Correct deficiencies identified during any stage of the Commissioning process.
- 1.5.5.11. Coordinate with the CxA to develop the Training Plan and submit to the Owner for approval. Provide training to the Owner's personnel in accordance with the Contract Documents and the approved Training Plan. Coordinate with the Owner to schedule training sessions and coordinate subcontractor/vendor participation in all training sessions.

- 1.5.5.12. Perform Deferred Testing and make necessary amendments to Operating and Maintenance Manuals and as-built drawings for applicable issues identified during the Deferred Testing.
- 1.5.5.13. Perform system maintenance during construction as specified and recommended by the Owner and send the maintenance records to the Owner for Record.
- 1.5.5.14. Document the equipment as it arrives onsite to ensure that the submitted and received equipment is correct as it arrives onsite, including the completion of the system verification sections pertaining to the procurement process.

1.6. SYSTEMS TO BE COMMISSIONED

1.6.1. The following systems shall be commissioned according to the process defined in this Section:

- 1.6.1.1. Major HVAC Systems (100% including but not limited to the list below)
 - 1.6.1.1.1 Air Handling Units
 - 1.6.1.1.2 Fan Coil Units
 - 1.6.1.1.3 Exhaust Fans
 - 1.6.1.1.4 Supply Fans
 - 1.6.1.1.5 Pumps
 - 1.6.1.1.6 Chillers
 - 1.6.1.1.7 Boilers
- 1.6.1.2. Terminal Units (10% Sampling)
- 1.6.1.3. Building Automation System
- 1.6.1.4. Lighting Controls - Occupancy Sensors (25% greater than 25 sensors installed, 100% less than 25 sensors installed)
- 1.6.1.5. Lighting - Daylight Controls (100%)
- 1.6.1.6. Lighting - Time Switch Controls (100%)
- 1.6.1.7. Normal and Emergency Power Systems

PART 2 - PRODUCTS

2.1. COMMISSIONING PLAN

- 2.1.1. Document developed by the CxA that provides the structure, schedule, and coordination plan for the Commissioning Process from the Pre-construction phase through the Occupancy Phase. The Commissioning Plan shall describe the project and systems to be commissioned, Commissioning Process activities and deliverables, procedures to follow throughout the process, specific roles and responsibilities for each participant, and general description of testing and verification methods.
- 2.1.2. The Commissioning Plan shall comply with the Owner's Project Requirements (OPR).
- 2.1.3. The Commissioning Team shall review the Commissioning Plan prior to the Pre-Commissioning Meeting and submit written comments or questions to the CxA to be addressed in the meeting.
- 2.1.4. Following the Pre-Commissioning meeting, the CxA shall incorporate all changes discussed and agreed upon in the Pre-Commissioning meeting and submit the Final Commissioning Plan to the Commissioning Team for approval and acceptance.

GENERAL COMMISSIONING REQUIREMENTS

- 2.1.5. If changes to the Commissioning Plan are needed during the Commissioning Process, the CxA shall edit the plan and distribute to the Commissioning Team for approval and acceptance.
- 2.1.6. The Contractor's acceptance shall constitute acceptance of all parties sub-contracted to the Contractor. The Contractor shall ensure that all sub-contractors and vendors agree and accept the Commissioning Plan.

2.2. SYSTEM VERIFICATION CHECKLISTS

- 2.2.1. System Verification Checklists (SVCs) are important to ensure that the equipment and systems are connected and operational and that Functional Performance Testing proceeds without unnecessary delays. These checklists document the inspections and procedures necessary to take a piece of equipment from a static state into an operating state. These checklists augment the manufacturer's start-up checklists to provide a complete document from procurement to the start of Functional Performance Testing when combined.
- 2.2.2. The CxA shall develop the System Verification Checklist templates for review by the Cx Team. The Contractor, appropriate Subcontractors and Vendors shall support the CxA in development of SVCs for each system and components by providing any necessary supporting documentation as requested by the CxA and reviewing and commenting on the checklist templates in accordance with the Project Specifications and the Commissioning Plan.
- 2.2.3. Once the checklist templates are reviewed and accepted, the CxA will produce checklists for all equipment and components to be commissioned on the project utilizing an electronic commissioning database that is accessible via web portal or local field tool (i.e., iPad, tablet, laptop, etc.).
- 2.2.4. The CxA shall provide login access and training to the Contractor and other members of the Cx Team in the use of the electronic commissioning database.
- 2.2.5. The Contractor shall be responsible for completing the required sections of the System Verification Checklists utilizing the electronic commissioning database and providing all supporting documentation via electronic transmittal to the CxA. Additional requirements for completion of the SVCs are included in this section and other technical sections of the Specifications.
- 2.2.6. Once equipment arrives on the project site, the Contractor or sub-contractors shall begin completing the individual checklists and continue throughout the installation process. The checklists are meant to be progressive and a tool for tracking progress.
- 2.2.7. Once the SVCs are electronically completed, the CxA will review and approve the checklists and supporting documentation and compile the information to include in the Final Commissioning Process Report.

2.3. FUNCTIONAL PERFORMANCE TESTING PROCEDURES:

- 2.3.1. The purpose of the Functional Performance Testing Procedures is to verify and document that the equipment and systems on the project individually perform in accordance with the requirements in the Contract Documents and meet the Owner's Project Requirements.
- 2.3.2. The CxA shall develop specific script-type test procedures to verify and document proper operation of each piece of equipment and system. The Contractor shall provide any supporting information to the CxA that may be needed including but not limited to product submittals, O&M information, and sequences of operation. Once developed, the CxA will issue to the Cx Team for review and comment.

- 2.3.3. The Commissioning Team shall review the Functional Performance Test procedures and submit written comments or questions to the CxA. The Contractor shall ensure that the sub-contractors and any vendors that would be involved with Functional Performance Testing review the procedures and provide comments.
- 2.3.4. The CxA will coordinate with the Cx Team to address any comments and produce the final FPT procedures for acceptance by the Cx Team. The Contractor's acceptance shall constitute acceptance of all parties sub-contracted to the Contractor.
- 2.3.5. The Contractor shall utilize the FPT procedures for any pre-testing activities prior to Functional Performance Testing.

2.4. INTEGRATED SYSTEMS TESTING PROCEDURES:

- 2.4.1. The purpose of the Integrated Systems Testing Procedures is to verify and document that all the integrated equipment and systems on the project perform together in accordance with the requirements in the Contract Documents and meet the Owner's Project Requirements.
- 2.4.2. The CxA shall develop specific script-type test procedures to verify and document proper operation of the integrated systems throughout the facility. The Contractor shall provide any supporting information to the CxA that may be needed including but not limited to product submittals, O&M information, and sequences of operation. Once developed, the CxA will issue to the Cx Team for review and comment.
- 2.4.3. The Commissioning Team shall review the Integrated Systems Testing procedures and submit written comments or questions to the CxA. The Contractor shall ensure that the sub-contractors and any vendors that would be involved with Integrated Systems Testing review the procedures and provide comments.
- 2.4.4. The CxA shall coordinate with the Cx Team to address any comments and produce the final IST procedures for acceptance by the Cx Team. The Contractor's acceptance shall constitute acceptance of all parties sub-contracted to the Contractor.
- 2.4.5. The CxA shall also develop the IST personnel matrix that will be utilized to track the individual testing teams involved with the IST. The CxA will distribute the matrix to the Cx Team so that the Contractor and Owner can assign the appropriate personnel to the appropriate teams.
- 2.4.6. The CxA shall also host a coordination meeting prior to the IST to review the IST procedures, complete any final coordination, review safety procedures, and answer any questions.
- 2.4.7. The CxA estimates there will be two Integrated Systems Tests on the project. The first will test the Data Center systems separately and the second will test the entire facility. Requirements of the testing are included in the respective technical sections of the Project Specifications.
- 2.4.8. The IST procedures shall be utilized by the Contractor for any pre-testing activities prior to official Integrated Systems Testing.

2.5. TRAINING PLAN

- 2.5.1. Contractor, in coordination with Owner and CxA, shall develop the Training Plan with project specific requirements for Owner Training, after reviewing the different systems to be installed and commissioned. The purpose of the Training Plan is to specifically communicate the required content and training durations required by the Owner based upon the type of equipment and the Owner's past experience.

- 2.5.2. The Contractor shall review all of the individual technical sections of this specification for specific training requirements.
- 2.5.3. The Contractor shall coordinate with the Owner to ensure that the proposed training requirements meet the Owner's needs and expectations.
- 2.5.4. The Contractor shall coordinate with the sub-contractors and vendors to ensure the Owner Training requirements can be achieved and gather any additional information or recommendations.
- 2.5.5. Any changes to the training requirements in this specification must follow contractual protocols.
- 2.5.6. The Training Plan shall include a list of systems and equipment for which training will be provided according to the three-tiered training approach outlined in the project specifications.
- 2.5.7. All training sessions shall have a syllabus indicating the following as a minimum in addition to any other specification requirements:
 - 2.5.7.1. Session Objectives
 - 2.5.7.2. Proposed Instructor(s)
 - 2.5.7.3. Instructor Qualifications
 - 2.5.7.4. Training Materials that will be provided
 - 2.5.7.5. Location and durations of the various parts of the training session (i.e., Classroom, On-site, etc.)
 - 2.5.7.6. Applicable specification sections and O&M Manual sections
 - 2.5.7.7. Detailed outline of training session content
- 2.5.8. The Contractor shall coordinate with the CxA to organize the systemic training sessions comparable to the organization of the Systems Manual.
- 2.5.9. Owner training must be completed prior to the contractor obtaining substantial completion by the Owner.

2.6. FINAL COMMISSIONING PROCESS REPORT

- 2.6.1. The CxA shall prepare the Final Commissioning Process Report that will include the following:
 - 2.6.1.1. Executive Summary
 - 2.6.1.2. Participants and Roles
 - 2.6.1.3. Brief building description
 - 2.6.1.4. Overview of commissioning and testing scope
 - 2.6.1.5. General description of testing and verification methods
 - 2.6.1.6. Appendices with supporting information, issues log, and communications
- 2.6.2. The Contractor shall coordinate with the CxA to provide any additional information that may be needed to complete the Final Commissioning Process Report.

- 2.6.3. The Contractor shall resolve any outstanding commissioning items prior to the CxA preparing the final commissioning report.
- 2.6.4. The CxA shall issue the Final Commissioning Process Report to the Cx Team for review. The Owner shall approve the Final Commissioning Process report after any comments or discrepancies are resolved by the CxA.

PART 3- EXECUTION

3.1. PROJECT SCHEDULE

- 3.1.1. The Contractor shall integrate all Commissioning activities into the detailed Project Schedule. All parties will address scheduling problems and make necessary notifications in a timely manner to expedite the Commissioning Process.

3.2. COMMISSIONING TEAM MEETINGS

- 3.2.1. Upon obtaining Owner's approval of the Commissioning Plan, the CxA shall coordinate with the Cx Team to schedule, plan, and conduct a Pre-Commissioning Meeting with all parties involved in the Commissioning process. This meeting should include the major subcontractors, specialty manufacturers/suppliers, Architect/Engineer, Test, Adjust, and Balance (TAB) Firm, Electrical Testing Agency, and Owner's representatives as participants.
- 3.2.2. Contractor shall prepare for the Pre-Commissioning Meeting by supplying the following documents created by the CxA to all applicable sub-contractors and vendors: Commissioning Plan, Example System Verification Checklists, Example Functional Performance Test Procedures and Example Integrated Systems Test Procedures.
- 3.2.3. The CxA shall conduct the Pre-Commissioning Meeting and review all aspects of the Commissioning Plan and applicable specifications.
- 3.2.4. The Commissioning Plan shall be reviewed with all attendees and the scope of work discussed. Contractor should be prepared to distribute copies of the pertinent sections to the various subcontractors involved in the Commissioning process.
- 3.2.5. The final outcome of the meeting shall be an understanding of the commissioning process, roles and responsibilities, and consensus acceptance of the Commissioning Plan by the Cx Team.
- 3.2.6. The Contractor may request additional meetings with the CxA and individual sub-contractors to clarify roles, responsibilities and procedures as needed.

3.3. TEST EQUIPMENT

- 3.3.1. Contractor shall provide all specialized tools, test equipment and instruments required to execute start-up, checkout, and testing of equipment.
- 3.3.2. All specialized tools, test equipment and instruments required to execute start-up, checkout, and testing of equipment shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated test equipment within the previous twelve (12) months. Calibration shall be NIST traceable. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

3.4. REPORTING

- 3.4.1. Beginning at the procurement stage for the equipment included in the Cx scope, the Contractor shall communicate at least monthly with all members of the Commissioning Team, keeping them apprised of construction progress and scheduling changes.
- 3.4.2. Contractor shall submit Deficiency reports to the Owner within five (5) days of the deficiency occurrence. This includes responses to items noted by the Commissioning Authority.

3.5. DEFICIENCY RESOLUTION

- 3.5.1. The CxA shall document any issues noted during observation or testing activities in the Commissioning Issues Log (CxIL). The CxIL shall be distributed electronically to the Cx Team at regular intervals.
- 3.5.2. The Contractor shall respond in writing to the CxA within 10 days to all new CxIL items regardless of the disposition. This response does not constitute a request for re-verification, only an acknowledgement of the outstanding item. The Contractor should utilize CxIL responses to update the Cx Team on the progress of deficiency resolution.
- 3.5.3. The Contractor shall respond to the CxA and the Owner indicating CxIL items that are completed and ready for the CxA to verify completion.
- 3.5.4. If any item indicated complete by the Contractor is found to be incomplete by the CxA upon re-verification the Contractor is responsible for all costs and additional compensation resulting from incomplete Cx Issues Log items.

3.6. REQUEST FOR ENERGIZING / START-UP OF EQUIPMENT

- 3.6.1. The Owner and/or Owner's representative may install lockout devices on equipment in addition to the Contractor's lockout / tagout devices once permanent power is connected to the facility. This lock would be removed once the proper start-up notification is received by the Owner and/or CxA, and the CxA has reviewed the appropriate SVCs and supporting documentation to verify the equipment is ready for energizing and/or start-up.
- 3.6.2. These requirements do not supersede any additional requirements noted elsewhere in the Contract Documents or as required by applicable code authorities.
- 3.6.3. Contractor shall notify Owner and CxA in writing to request initial energizing and/or start-up of equipment and systems at least 72 hours (not including weekends or holidays) prior to the scheduled start-up.
- 3.6.4. Contractor shall complete the applicable sections of the System Verification Checklist(s) evidencing the Contractor's thorough inspection of the system and readiness for start-up activities as required by the Project Documents and the Commissioning Plan. Contractor shall submit required supporting documentation to the Owner and/or CxA, including but not limited to, factory testing reports, alignment reports, electrical testing reports and any other documentation required by the Project Documents prior to energizing and/or start-up.
- 3.6.5. The CxA shall review the SVCs and supporting documentation within the 72 hour notice period and confirm in writing that the systems and equipment are approved to proceed with energizing and start-up.
- 3.6.6. The CxA and/or owner may witness equipment energizing and/or start-up at the scheduled time, but witness is not required, unless noted elsewhere in the Specifications, as long as written approval is received as noted herein.

- 3.6.7. Contractor shall perform Start-up under supervision of the responsible manufacturer's representative in accordance with manufacturer's instructions and Project Document requirements.
- 3.6.8. Contractor shall complete all required factory start-up documentation and applicable items in the System Verification Checklists, prior to startup, to ensure compliance with the requirements in the Project Documents.

3.7. OPERATIONAL TESTING

- 3.7.1. Once the appropriate start-up activities are completed, the Contractor shall complete all necessary operational testing requirements included in the Project Documents prior to Functional Performance Testing. Specific requirements for systems and equipment are included in other technical sections of the Specifications.
- 3.7.2. Contractor shall complete all operational testing items in the System Verification Checklist and submit all supporting documentation to the Owner and/or CxA for review.
- 3.7.3. Contractor and manufacturer's representatives shall supervise and coordinate adjustments and balancing of all devices and systems for proper operation prior to requesting a Functional Performance Test(s).
- 3.7.4. Contractor shall clearly list outstanding items or System Verification Checklist items not completed successfully. Contractor shall obtain from Subcontractor or vendor completed forms documenting any outstanding deficiencies within five (5) days of completion of energizing and/or start-up activities.
- 3.7.5. Contractor shall review completed deficiencies to determine if outstanding items prevent execution of the Functional Performance Tests and shall issue any necessary responses to the Owner and/or Commissioning Authority.
- 3.7.6. Contractor shall notify Owner and CxA in writing to request Functional Performance Testing of equipment and systems at least 72 hours (not including weekends or holidays) prior to the scheduled activities. Owner may require Contractor to reschedule Functional Performance Testing to ensure availability of Owner's representative(s) as needed.
- 3.7.7. The CxA shall review the SVCs and supporting documentation within the 72 hour notice period and confirm in writing that the systems and equipment are approved to proceed with Functional Performance Testing.
- 3.7.8. If any item indicated complete by the Contractor is found to be incomplete by the CxA upon re-verification the Contractor is responsible for all costs and additional compensation resulting from incomplete System Verification Checklist items.

3.8. CONTROL POINT AND SENSOR CALIBRATION VERIFICATION

- 3.8.1. Automation systems installed on the project must be fully verified for point integrity and sensor calibration prior to Functional Performance Testing. Additional requirements for this verification are listed in other technical sections of the Specifications.
- 3.8.2. The Contractor shall verify these points according to the requirements in the project documents as part of start-up and operational testing of systems.
- 3.8.3. The TAB contractor shall independently verify each sensor and point and document the results to be included in the Final TAB Report.

- 3.8.4. The CxA will witness, at their discretion, this verification and/or independently verify and document the results to be included in the Final Commissioning Process Report.
- 3.8.5. These activities must be completed prior to the Contractor requesting Functional Performance Testing as indicated herein.

3.9. FUNCTIONAL PERFORMANCE TESTING

- 3.9.1. The objective of Functional Performance Testing is to demonstrate that each system operates according to the requirements in the Project Documents and meets the OPR and BOD.
- 3.9.2. Contractor shall operate, or cause to be operated, each system, device, or equipment item, both intermittently and continuously, for a duration period as indicated in the Specification Section(s) for each item and/or in accordance with the Project Documents, the Commissioning Plan and applicable Functional Performance Testing procedures.
- 3.9.3. Contractor shall operate each component device and each building system to the full extent of its capability, from minimum to maximum, and under automatic control and manual control.
- 3.9.4. The CxA and members of the Cx Team, including the Owner's personnel, may observe Functional Performance Testing of equipment components and systems. The CxA shall facilitate the Functional Performance Testing activities according to the accepted FPT procedures and record the results of all testing activities.
- 3.9.5. The CxA shall record any deficiencies noted during the testing in the CxIL. If significant deficiencies exist, the owner and/or CxA may request that the testing activities be terminated and re-scheduled after proper verification by the Contractor. The Contractor is responsible for all costs and additional compensation resulting from deficiencies and incomplete systems noted during scheduled Functional Performance Testing.
- 3.9.6. All Functional Performance Testing of Integrated Systems must be completed in accordance with the Project Documents and the Commissioning Plan prior to the Contractor scheduling the Integrated Systems Testing activities.

3.10. INTEGRATED SYSTEMS TESTING

- 3.10.1. The objective of Integrated Systems Testing is to demonstrate that each integrated system operates jointly and/or independently of other systems according to the requirements in the Contract Documents.
- 3.10.2. Contractor shall operate each system, jointly and independently of other systems, through selected modes of operation (fire alarm integration with HVAC, emergency power modes, equipment failures among related systems, etc.) according to the accepted Integrated Systems Testing procedures developed by the CxA. The CxA shall facilitate and document the testing, organizing the appropriate testing teams and providing sufficient instruction to all participants to conduct efficient and effective testing activities.
- 3.10.3. Integrated Systems Testing typically involves multiple teams with representation from the CxA, Owner, and Contractor. The Contractor shall provide any needed communication equipment (i.e., radios) or make available any centralized intercom or paging system for communication with all testing groups.
- 3.10.4. The Contractor shall provide no less than 7 days (not including weekends or holidays) notice when requesting to conduct the Integrated Systems Testing. All personnel must be assigned to the Personnel Matrix by the CxA and a coordination meeting held within the 7 day period as prescribed elsewhere in this section.

- 3.10.5. Contractor conducts Integrated Systems Testing after all applicable Functional Performance Testing is satisfactorily completed and approved by the Owner and/or CxA.
- 3.10.6. The CxA shall record any deficiencies noted during the testing in the CxIL. If significant deficiencies exist, the owner and/or CxA may request that the testing activities be terminated and re-scheduled after proper verification by the Contractor. The Contractor is responsible for all costs and additional compensation resulting from deficiencies and incomplete systems noted during scheduled Integrated Systems Testing.

3.11. DEMONSTRATION AND OWNER TRAINING

- 3.11.1. The Contractor, in coordination with Owner and CxA, shall develop the Training Plan with project specific requirements for Owner Training as required throughout various sections of the Project Specifications.
- 3.11.2. The specific requirements for scheduling and conducting the Owner Training are included in other sections of this Specification.
- 3.11.3. Owner Training activities shall not occur until the Training Plan is approved by the Owner and the Contractor has submitted all O&M information for review and use during the training sessions.
- 3.11.4. The Contractor shall notify the CxA of all training sessions. The Contractor shall record attendance of the training sessions and the Owner shall ensure the appropriate personnel are in attendance.
- 3.11.5. The CxA shall ensure the content of the Owner Training sessions meets the requirements in the Project Documents.
- 3.11.6. The CxA may conduct surveys of the Owner's personnel to gauge the effectiveness of the Owner training sessions. If unfavorable surveys are received by the Owner's personnel indicating unsatisfactory training, the Owner reserves the right to require the Contractor to re-train in those specific areas of non-conformance until the requirements in the Project Documents are satisfactorily completed.
- 3.11.7. Owner training must be completed prior to the contractor obtaining substantial completion by the Owner.

3.12. DEFERRED / SEASONAL TESTING

- 3.12.1. All Construction phase requirements of the Commissioning Process must be completed prior to Substantial Completion or as indicated elsewhere in this Specification.
- 3.12.2. If any testing or other requirements cannot be completed prior to Substantial Completion due to the building structure, required occupancy condition, or other condition, performance of such test may be delayed to later in the warranty period, upon approval of the Owner. Contractor shall re-schedule testing according to the protocols described in this section and any other operational protocols prescribed by the Owner.
- 3.12.3. Contractor shall complete all outstanding commissioning requirements as part of this Contract during the warranty period. Contractor shall schedule all activities with Owner and/or CxA.

The CxA shall document any deferred testing activities and ensure the appropriate commissioning documents are updated. The Contractor shall provide any additional documentation needed by the CxA to complete these requirements.

END OF SECTION 01 45 23

SECTION 01 45 23 - TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements and qualifications including but not limited to:
 - 1. Professional testing and laboratory services.
 - 2. Accessories necessary for the completion of testing and laboratory services.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. A qualified independent testing laboratory and/or geotechnical engineering service selected and paid by Owner.
 - 1. The Owner will pay for the initial laboratory services of materials that comply with the requirements of the Contract Documents. The Contractor shall pay for testing and retesting of materials that do not comply with the requirements of the Contract Documents.
- D. Inspecting agency shall perform inspections and tests in accordance with the rules and regulations of the building code, local authorities, Specifications of ASTM, and the Contract Documents.
- E. Materials and workmanship found not in compliance with required standards or performance obligations shall be removed and replaced. Replacement and subsequent testing shall be at Contractor's expense.
- F. Where terms "Inspector" and "Laboratory" are used, it is meant and in reference to an officially designated and accredited inspector of the testing laboratory or geotechnical service engaged by Owner.
- G. Laboratory inspections shall not relieve the Contractor or Fabricator of his responsibility to furnish materials and workmanship in accordance with the Contract Documents.
- H. Contractor or Fabricator shall cooperate with the testing laboratory in matters pertaining to the Work.
- I. Contractor to address deficiency and failed reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329 and ASTM E534; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
 - 3. Testing agencies shall be insured against errors and omissions by a professional liability insurance policy having a minimum limit of liability of \$500,000.00.
- B. Inspection and testing services the of testing agency shall be under the direction of a Registered Engineer licensed in the State of Texas, charged with engineering managerial responsibility, and having a minimum of five (5) years engineering experience in inspection and testing of construction materials.
- C. Concrete Inspectors: Inspecting personnel monitoring concrete Work shall be ACI certified inspectors.
- D. Structural Steel: Primary inspectors performing structural steel inspection shall be currently certified AWS Certified Welding Inspectors (CWI), in accordance with the provisions of AWS QCI, *Standard and Guide for Qualification and Certification of Welding Inspectors*.
 - 1. Inspector may be supported by assistant inspectors who perform specific inspection functions under the direct supervision of the Primary Inspector. Assistant inspectors shall be currently certified AWS Certified Associate Welding Inspectors (CAWI). Work of assistant inspectors shall be monitored daily by the inspector.
- E. Testing Equipment: Equipment shall be calibrated at intervals not exceeding 12 months by devices of accuracy traceable to the National Bureau of Standards.
- F. Referenced Standards: Latest adopted edition of standards referenced apply to the Work. In the event of conflict between the Contract Documents and referenced standards, the Contract Documents shall govern. In case of conflict between Contract Documents and the Building Code, the more stringent shall govern.

1.4 QUALITY CONTROL

- A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
 - 1. Refer to the individual specification sections for specific requirements.
 - 2. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 3. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 5. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
 6. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
 8. Associated Responsibilities and Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - a. Provide access to the Work.
 - b. Deliver of samples to testing laboratory, without cost to Owner, in adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 - c. Advise laboratory and Architect sufficiently in advance of construction operations to allow laboratory to complete required inspections or tests and to assign personnel for field inspection and testing as specified.
 - d. Provide facilities for storage and curing of concrete test samples on site for the first 24 hours and for subsequent field curing required by ASTM C31.
 - e. Incidental labor, facilities, and equipment necessary to assist laboratory personnel in obtaining and handling samples at the site.
 - f. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - g. Provide concrete mix designs in accordance with ACI 301 Section 3.9 made by an independent testing laboratory or qualified concrete supplier. Where mix designs by an independent testing laboratory are required, select and pay for laboratory.
 - h. Obtain required inspections or approvals of the building official. Inspection requests and notifications required by building code are responsibility of the Contractor.
 - i. Provide current welder certificates for each welder employed.
 - j. Provide fabrication and erection inspection and testing of welds in accordance with AWS D1.1, Chapter 6.
 - 1) Use prequalification of welding procedures in executing the Work.
 - k. Security and protection for samples and for testing and inspecting equipment at Project site.
 9. Retesting/Reinspecting: Regardless of payment responsibility of the original tests or inspections, provide quality control services, including retesting and reinspecting, for construction that replaced Work failing to comply with the Contract Documents or Code requirements.
- C. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.

6. Do not perform any duties of Contractor.

- D. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.5 AUTHORITY AND DUTIES OF LABORATORY PERSONNEL

- A. A representative of the testing laboratory, who has reviewed and is familiar with the project and specifications, shall participate in preconstruction conferences. The representative shall coordinate material testing and inspection requirements with the Contractor and its subcontractors consistent with the planned construction schedule. The laboratory representative shall attend conferences required or requested to address quality control issues.
- B. Laboratory personnel shall inspect and test materials, assemblies, specimens, and Work performed, including design mixes, methods and techniques and report the progress to the Architect.
- C. If material or Work fails to meet requirements of Contract Documents, laboratory inspector shall notify the Construction Manager, Architect, Engineers, supplier or subcontractor providing or preparing the materials or Work being tested of such failure.
- D. Laboratory personnel shall not perform the Work of the Contractor or act as foremen or superintendents. Work will be inspected as it progresses, but failure to detect defective Work or materials shall not prevent later rejection when a defect is discovered.
- E. Laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release the requirements of the Contract Documents or approve or accept portions of Work, except where approval is specifically specified in the Specifications.
- F. Comply with building code requirements for Special Inspections.

1.6 SUBMITTALS

- A. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
- B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
 2. Entity responsible for performing tests and inspections.
 3. Description of test and inspection.
 4. Identification of applicable standards.
 5. Identification of test and inspection methods.
 6. Number of tests and inspections required.
 7. Time schedule or time span for tests and inspections.
 8. Requirements for obtaining samples.
 9. Unique characteristics of each quality control service.
- C. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.

6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- D. Submit copies of reports of each inspection and test:
1. Owner, Program or Project Manager, Architect, and each Engineer or outside consultants regarding their particular phase of the project: One copy each.
 2. Construction Manager and Contractor: Two copies each.
- E. In addition to furnishing a written report, notify Construction Manager and Contractor verbally of uncorrected conditions or failures to comply with requirements of the Contract Documents, and immediately fax and email corresponding report to the Architect and Engineer.
- F. At completion of each trade or branch of Work requiring inspecting and testing, submit a final certificate attesting to satisfactory completion of Work and full compliance with requirements of Contract Documents.
- G. Submit copies of test results sealed by a Registered Engineer to municipal authorities having jurisdiction, as required.

1.7 TESTING LABORATORY GUIDELINES AND PROCEDURES

- A. Technicians scheduled to perform specific testing services must be qualified to review and perform other services that overlap, i.e. earthwork, foundation inspections, rebar inspection, and concrete when scheduled concurrently at the site.
- B. Technician time for services performed will be reimbursed at a regular time rate. Compensation at the overtime rate will be considered for hours over eight hours spent at the site on a single day, field testing services performed on a Saturday or Sunday, and field services performed on a recognized holiday.
- C. There shall be a three hour minimum for each scheduled testing service. Vehicle charges will be included on a \$25.00 per trip basis.
- D. Cylinder pick up will be controlled by the technician performing test on a scheduled pick up day. If there are no testing services scheduled, the cylinder pick up fee is \$40.00 on week days and \$50.00 on weekends and holidays with no technician or vehicle charge.
- E. The Contractor shall bear the responsibility of scheduling the testing services. The Contractor and the testing laboratory shall assume full responsibility to coordinate the testing services. Cancellations or failed test shall be reimbursable to the Owner by the responsible party for the cancellations or failure of a test or service.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Architect.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
 - 5. Deficiency log.
- B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 TESTING AND INSPECTION SERVICES

- A. Testing services shall include, but not be limited to those specified below or which are necessary or required during course of construction to ascertain specification compliance and which may be deemed necessary by Architect, Engineer, or Owner to ensure the quality of the Work.
- B. The Owner reserves the right to add to or delete any or all inspection and testing specified, excluding testing required by the applicable building codes.
- C. If conflicts arise between Drawings and Specifications, notify Architect immediately. The most stringent requirements shall dictate procedure.

3.3 TESTING OF EARTHWORK

- A. Testing Services (As specified or required):
 - 1. References (As applicable for tests required):
 - a. American Society for Testing and Materials (ASTM):
 - 1) D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³).
 - 2) D2922, Standard Test Method for Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth).
 - 3) D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - b. American Association of State Highway and Transportation Officials (AASHTO)
 - 1) T89, Determining the Liquid Limit of Soils.
 - 2) T90, Determining the Plastic Limit and Plasticity Index of Soils.
 - 3) T99, Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305-mm (12-in) Drop.
 - 4) T238, Density of Soil and Soil Aggregates In Place By Nuclear Methods (Shallow Depth).
 - 2. Perform sieve analysis to develop grain size distribution curves for materials to be used for subgrade, fill under slab on grade, and backfills.
 - 3. Establish the moisture density relation of soils to be used as fill using the method best suited to the type of fill material.
 - 4. Determine moisture content of all fill materials before placement and advise Contractor when it is or is not suitable to achieve required compaction.
 - 5. Determine Liquid Limit in accordance with ASTM D4318 or AASHTO T89, Plastic Limit in accordance with ASTM D4318, and Plasticity Index in accordance with ASTM D4318 of all fill material,

6. Perform one in place density test for each 4,000 square feet (445 square yards) of existing subgrade material.
 7. Perform Moisture-Density curve in accordance with ASTM D698 or AASHTO T99 for one type of fill material. If the original choice of material does not meet the specifications, the Contractor shall pay for additional testing.
 8. Perform in place density tests of each lift of compacted fill at locations adequate to evaluate the degree of compaction of all fill areas. Conduct one test for each 4,000 square feet (445 square yards) of each lift of compacted fill.
 9. Perform testing at a frequency of one in-place density and moisture test for each 75 lineal feet or less of utility trench, with a minimum of three tests per lift.
- B. Reports: Submit reports with the following information:
1. Type and condition of soil at footing bottoms.
 2. Level of water table in the excavated areas.
 3. Grain size distribution of fill materials (average of three tests).
 4. Moisture density test results.
 5. In place density test results with moisture content and relative density of each layer of compacted fill. Include with in place density test results, a plan showing location of each test.
 6. Notify Architect by telephone within one hour of the discovery of the following conditions and follow up telephone notification with written report.
 - a. Materials used, or degree of soil compaction not meeting specified requirements.
 - b. Frost and freeze protection requirements for excavation bottoms not being complied with.
 - c. Water in excavations which is not being removed prior to Work being performed in excavation.

3.4 INSPECTION OF PIPED SITE UTILITIES

- A. Laboratory representative shall observe and report on the following:
1. Proper alignment and grade of trenches.
 2. Pipe bedding and supports.
 3. Pipe, joints, jointing material, and thrust blocks prior to installation of pipe.
 4. Installation of pipe and joints.
 5. Testing of piped utilities performed by Contractor.

3.5 PAVING

- A. Testing Services: Perform field tests for moisture density properties:
1. Provide field testing of the subgrade as specified.
 2. Paving Subbase: Provide one field test for every 7,500 square feet of area of crushed limestone or caliche subbase.
 3. Lime Treated Subgrade: Provide one field test for every 7,500 square feet of area of lime treated subgrade for content of lime and subgrade compaction.
 4. Cement Soil Stabilization: Provide one field test for every 7,500 square feet of area of cement stabilized subgrade for content of cement and subgrade compaction.

3.6 PIER DRILLING OPERATION

- A. A representative of a qualified geotechnical laboratory shall provide services specified.
- B. Laboratory representative shall make continuous inspections to determine that proper bearing stratum is obtained and utilized for bearing and that shafts are properly clean and dry before placing concrete.

- C. Laboratory shall furnish complete pier log showing the diameter, top and bottom elevations of each pier, casing required or not required, actual penetration into bearing stratum, elevation of top of bearing stratum, volume of concrete used, and deviations from specified tolerances.
- D. Laboratory representative shall make continuous inspections of drilled pier construction to check the following:
 - 1. Verify soundness of bearing stratum and desired penetration.
 - 2. Verify pier dimensions and reinforcing used.
 - 3. Monitor condition of hole and removal of water and loose material from bottom.
 - 4. Monitor placement of concrete and use of tremie or pumps.
 - 5. Monitor the extraction of casing, if used.
- E. Request probe holes when deemed necessary to confirm safe bearing capacity.

3.7 CONCRETE REINFORCING STEEL AND EMBEDDED METAL ASSEMBLIES

- A. Inspect concrete reinforcing steel prior to placing concrete for compliance with Contract Documents and approved shop drawings. Noncompliance with Contract Documents and approved shop drawings shall be immediately brought to the attention of the Contractor for correction and, if left uncorrected, reported to the Architect.
- B. Laboratory representative shall observe and report on the following:
 - 1. Number and size of bars.
 - 2. Bending and lengths of bars.
 - 3. Splicing.
 - 4. Clearance to forms, including chair heights.
 - 5. Clearance to sides and bottom of trench if soil formed.
 - 6. Clearance between bars or spacing.
 - 7. Rust, form oil, and other contamination.
 - 8. Grade of steel.
 - 9. Securing, tying, and chairing of bars.
 - 10. Excessive congestion of reinforcing steel.
 - 11. Installation of anchor bolts and placement of concrete around such bolts.
 - 12. Fabrication and installation of embedded metal assemblies, including visual inspection of all welds.
 - 13. Visually inspect studs and deformed bar anchors on embedded assemblies for compliance with Contract Documents. Check number, spacing and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud or bar, such stud or bar shall be struck with a hammer and bent 15 degrees off perpendicular and then bent back into position. Anchors failing this test shall be replaced.
- C. Provide a qualified, experienced inspector to inspect reinforcing steel. Inspector shall have a minimum of three years' experience inspecting reinforcing steel in projects of similar size.

3.8 CONCRETE INSPECTION AND TESTING

- A. Receive and evaluate proposed concrete mix designs submitted by Contractor. If mix designs comply with Drawings and Specifications, the laboratory shall submit a letter to the Architect certifying compliance. Mix designs not complying with Drawings and Specifications shall be returned by the laboratory as being unacceptable. Check the proposed mixes for proportions, water cement ratio and slump in accordance with ACI 613 and 318.
- B. Comply with ACI 311 *Guide For Concrete Inspection* and ACI *Manual of Concrete Inspection* (SP-2).

- C. Sample and test concrete placed at the site in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis.
- D. Test concrete:
 - 1. Mold and cure five specimens from each sample.
 - a. For each 50 cubic yards or fraction thereof of structural building concrete; and
 - b. For each 100 cubic yards or fraction thereof of nonstructural concrete and site Work paving and sidewalks.
 - c. Laboratory cure two cylinders in accordance with ASTM C192.
 - d. Field cure remaining cylinders in accordance with ASTM C31.
 - 2. Two specimens shall be tested at seven days for information, two shall be tested at 28 days for acceptance.
- E. Deviations from the requirements of ASTM Specifications shall be recorded in the test report. Test concrete specimens in accordance with ASTM C39.
- F. Specimens for pumped concrete shall be taken at the discharge end of pumping equipment.
- G. Supervise curing and protection provided for test specimens in field, and transportation from the field to laboratory. Test cylinders shall be stored in the field 24 hours and then carefully transported to laboratory and cured in accordance with ASTM C31.
- H. Make one strength test (four cylinders) of each mix design of concrete placed in any one day.
- I. Make one slump test for each set of cylinders following procedural requirements of ASTM C143 and ASTM C172. Make additional slump tests whenever consistency of concrete appears to vary. Slump tests corresponding to samples from which strength tests are made shall be reported with strength test results. Other slump tests need not be reported.
- J. Determine total air content of air entrained normal weight concrete sample for each strength test in accordance with ASTM C231.
- K. Determine air content and unit weight of lightweight concrete sample for each strength test in accordance with ASTM C173 and ASTM C567.
- L. Determine temperature of concrete sample for each strength test.
- M. Inspect each batch of concrete, monitor addition of mixing water to assure uniform consistency from truck to truck. Check mixing form mixers before mix begins to set and within time limits set forth in ASTM C94.
 - 1. Monitor addition of water and high range water reducer to concrete at job site and length of time concrete is allowed to remain in truck during placement.
- N. Testing agency shall furnish and maintain a competent inspector at the mixing plant at the start of each day's mixing. Inspector shall examine concrete materials for compliance with Specifications and approved mix design, weighing and measuring devices, proportioning and mixing of materials, water and cement content of each batch, general operation of the plant, and transportation of concrete to jobsite. Inspector shall verify that amount of free surface moisture contained in fine and course aggregate has been properly accounted for in the concrete mixing to achieve required consistency and water cement ratio.
- O. Testing laboratory shall monitor addition of water to concrete at the jobsite and the length of time concrete is allowed to remain in the truck before placement. Inspector shall compare mixture with criteria on the approved mix design and report any significant deviation to the Architect, Contractor and concrete supplier. Do not permit addition of water which will exceed maximum water/cement ratio for the mix as given on the approved mix design.

- P. Observe placing of concrete, except nonstructural slabs on grade and site Work. Observe and report on placing method, consolidation, cold joints, length of drop, and displacement of reinforcement. Report deficiencies to Contractor immediately for corrective action. Inspections may be reduced to a periodic basis when all procedures have been deemed satisfactory by the laboratory.
- Q. Test reports shall include but not be limited to the following information: date of concrete placement, concrete mix identification number or proportion of ingredients, truck ticket number, time test was made, time of batching, location of each placement, slump, unit weight, water content (microwave test) and air content of concrete sampled and date and results of strength test.
- R. Report promptly to Architect all details of reasons for rejection of any and all quantities of concrete. Give all information concerning locations of the concrete pours, quantities, date of pours, and other pertinent facts concerning concrete represented by the specimens.
- S. Testing laboratory shall certify each delivery ticket indicating class of concrete delivered (or placed), amount of water added and time at which cement and aggregate were dispensed into the truck, and time at which concrete was discharged from the truck.
- T. Evaluation and Acceptance:
 - 1. If measured slump, or air content of air entrained concrete, falls outside specified limits, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, concrete shall be considered to have failed to meet the requirements of the specifications, and shall not be used in the structure.
 - 2. Strength level of concrete will be considered satisfactory if the averages of sets of three consecutive strength tests results are equal to, or exceed, specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
 - 3. Completed concrete Work will be accepted when requirements of ACI 301 Chapter 18 *Specifications for Structural Concrete for Buildings* have been met.
- U. Concrete Test Reports: Reports shall be made and distributed immediately after respective tests or inspections are made.
 - 1. Where reports indicate deviations from Contract Documents, they shall also include a determination of the probable cause of deviation and where applicable, a recommendation for corrective action.
- V. Furnish a statistical analysis for each class of concrete placed on the project in accordance with ACI 214 and ACI 318. Information shall be updated and distributed once a month as directed by the Architect. Information shall include, but not be limited to, the following:
 - 1. Strength tests at 7 days of one cylinder.
 - 2. Strength tests at 28 days of two cylinder averages.
 - 3. 28 day moving average strength tests of last three test groups.
 - 4. Standard deviation and coefficient of variation based on 28 day strength tests.
 - 5. Average strength and number of 28 days tests for most recent month.
- W. Test Footings (Shafts) (Piers) (Caissons): Same diameter and type specified for footings, placed in same manner. Accepted test footings may be used in the Work.
- X. Noncompliant Test Reports: Fax test reports indicating noncompliance immediately to each party on the test report distribution list. Copies shall be on different colored paper.
- Y. Inspect application of curing compound and monitor curing conditions to assure compliance with specification requirements. Report curing deficiencies to the Contractor immediately and submit a written report to the Architect.

3.9 TESTING OF NONSHRINK GROUT

- A. Make one strength test for all plates grouted and for all grout used in joints between members.
- B. Each test shall consist of four cubes, two tested at 7 days and two at 28 days, made and tested in accordance with ASTM C109, with the exception that grout shall be restrained from expansion by a top plate.

3.10 STRUCTURAL STEEL

- A. Inspect structural steel during and after erection for compliance with Contract Documents and shop drawings. Review and report on fabricator's quality control procedures and capabilities.
- B. Field Inspection:
 - 1. Proper erection of pieces.
 - 2. Proper touch up painting of shop primed structural steel exposed to view or in crawl space.
 - 3. Proper installation of bolts.
 - 4. Plumbness of structure and proper bracing.
 - 5. Proper field painting.
 - 6. Initial inspection of welding process and periodically thereafter as necessary.
 - 7. Visual examination of completed welds.
 - 8. Ultrasonic testing of penetration field welds.
 - 9. Installation of field welded shear studs.
 - 10. Inspect shop fabricated members, upon arrival at the site, for defects incurred during transit and handling.
 - 11. Measure and record camber of beams upon arrival and before erection for compliance with specified camber. Measure lying flat with web horizontal. Return members outside specified camber tolerance to shop for correction.
- C. Qualifications of Welders: Fabricator and erector shall provide the testing laboratory with names of welders employed on Work, along with certification that each welder has passed qualification tests within the past 12 months, using procedures covered in AWS D1.1 *Structural Welding Code - Steel*. Verify welder qualifications.
- D. Inspection of field welding shall include:
 - 1. Visually inspect fillet welds for size, soundness, and proper return around ends. Inspect seams, folds, and delaminations.
 - 2. Visually inspect welds for proper repair of painting.
 - 3. Ultrasonically test penetration welds in accordance with ASTM E164.
 - 4. Inspect surfaces to be welded. Note surface preparations, fit up, and cleanliness of surface. Verify electrodes for size, type, and condition.
 - 5. Welding inspector shall be present during alignment and fit up of members being welded, and shall verify for correct surface preparation of root openings, sound weld metal, and proper penetration in the root pass. Where weld has not penetrated completely, inspector shall order the joint to be chipped down to sound metal, or gouged out, and rewelded. Thoroughly inspect root passes for cracks. Gouge out cracks and rewelded to 2 inches beyond each end of crack.
 - 6. Inspector shall verify that welds have been marked with welder's symbol and shall mark welds requiring repairs and reinspection. Inspector shall maintain a written record of welds. Work completed and inspected shall receive an identification mark by the inspector. Identify unacceptable material and Work identified by word *reject* or *repair* marked directly on the material.
 - 7. Testing agency shall advise the Owner and Architect of any shop and/or field conditions which may require further tests and examination by means other than those specified. Additional tests and examinations shall be performed as authorized by the Owner and Architect.

8. Owner reserves the right to use ultrasonic or radiographic inspection to verify adequacy of welds. Testing procedures and acceptance criteria shall be as specified in AWS D1.1.
 9. Weld quality to comply with the American Institute of Steel Construction (AISC) Manual of Steel Construction.
 10. Determine percentage of weld tested by the number of welds that fail the initial testing.
 11. Reweld and retest welds that fail until the welds pass. Test two additional welds for every weld failure.
- E. Inspect bolted construction in accordance with AISC *Specification for Structural Steel Buildings*:
1. Visually inspect bolts ensuring that plies have been brought into snug contact.
 2. Inspect high strength bolt in accordance with Section 9 of the *Specifications for Structural Joints Using ASTM A325 or A490 Bolts*.
- F. Inspect stud welding in accordance with Section 7.8, of AWS D1.1 *Structural Welding Code*:
1. Weld at least two shear studs at the start of each production period to determine correct generator, control unit, and stud welder setting. The studs shall be capable of being bent 45 degrees from vertical without weld failure.
 2. When the temperature is below 32 degrees F (0 degrees C), test one stud in each 100 after cooling. Do not weld studs at temperatures below 0 degrees F or when surface is wet with rain or snow. If stud fails in the weld, two new studs shall pass the test before resumption of welding.
 3. Visually inspect studs for compliance with the requirements of the Contract Documents. Verify number, spacing, and weld quality. If, after welding, visual inspection reveals that a sound weld or a full 360 degree fillet has not been obtained for a particular stud, that stud shall be struck with a hammer and bent 15 degrees off perpendicular in the direction away from the missing weld. Studs failing test shall be replaced.

3.11 REINFORCING STEEL MECHANICAL SPLICES

- A. Inspection and Observation Services:
1. Visually inspect and report on completed condition of each mechanical splice of reinforcing steel.
 2. Visually inspect each mechanical splice to ensure compliance with the ICC-ES Reports and the manufacturer's published criteria for acceptable completed splices.
 3. Place special emphasis on the inspection of the end preparation of each bar to be spliced required by the ICC-ES Report.
- B. Reports: Submit reports to Architect:
1. Submit copies of manufacturer's published criteria for acceptable completed splices prior to observing mechanical splices.
 2. Reports on each mechanical splice shall indicate location of the splice, size of bars spliced, and acceptability or rejection of splice. Indicate reasons for rejection on each report.

3.12 OPEN WEB JOISTS AND JOIST GIRDERS

- A. Inspect joists at jobsite for compliance with specified fabrication requirements. Verify welded connections between web and chord, splices, and straightness of members.
- B. Inspect installation of joists at jobsite. Check connections to supporting members, chord extensions, number of rows of bridging, and bridging connections for compliance with Contract Documents and referenced standards.
- C. Verify welder qualification certificates for both shop and field welding operators.

3.13 METAL FLOOR DECK

- A. Field inspection shall consist of:
 - 1. Verifying types, gauges and finishes for compliance with Contract Documents and shop drawings.
 - 2. Examine composite floor deck exposed to crawl space for damage to galvanizing due to welding or construction activities. Repair galvanized composite floor deck in accordance with the specifications.
 - 3. Examine the erection of metal deck, fastenings, reinforcing of holes, deck reinforcing, miscellaneous deck supports, hanger tabs, shear studs, deck closures, painting or other coating.
 - 4. Certification of welders.
 - 5. Inspect and test field welded shear studs used to fasten metal floor decking to supporting steel as specified for structural steel.

3.14 METAL ROOF DECK

- A. Field inspection shall consist of:
 - 1. Verify types, gauges and finishes for compliance with Contract Documents and shop drawings.
 - 2. Examine the erection of the metal deck, including fastenings at supports and side laps, reinforcing of holes, and miscellaneous deck supports.
 - 3. Certification of welders.
 - 4. Visual inspection of at least 25 percent of welds.

3.15 SPRAYED FIREPROOFING

- A. Verify applied thickness, density, and bond strength of sprayed fireproofing meets fire rating requirements of approved design.
- B. Verify installation complies with fire rating requirements of approved design.
- C. Inspect and test for thickness:
 - 1. Test 25 percent of structural frame columns and beams in each building level.
 - 2. Test 10 percent of beams other than structural frame in each building level.
 - 3. Test one slab per 5,000 square feet of building area.
- D. Inspect and test in accordance procedures of ASTM E605 and ASTM E736.

3.16 EXPANSION BOLT INSTALLATION

- A. Inspect drilling of each hole and installation of each expansion bolt for compliance with Contract Documents and shop drawings.
- B. Verify installation torque for each expansion bolt for compliance with manufacturer's installation instructions.

3.17 LIGHTWEIGHT INSULATING CONCRETE FILL

- A. Inspection and Observation Services (As required):
 - 1. Inspection of roof deck prior to start of Work.
 - 2. Inspection during installation of insulation and lightweight insulating concrete fill Work to ascertain compliance with Contract Documents.
 - 3. Observation of base ply fastener pull tests performed by Contractor to ascertain minimum withdrawal resistance of 40 pounds per fastener.
- B. Testing Services (As required):

1. References (As applicable for tests required):
 - a. American Society for Testing and Materials (ASTM)
 - 1) C177 - Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties By Means of the Guarded Hot Plate Apparatus.
 - 2) C495 - Test Method for Compressive Strength of Lightweight Insulating Concrete.
 - 3) C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
2. Test EPS insulation board for thermal insulation value in accordance with ASTM C177.
3. Test lightweight insulating concrete fill in accordance with ASTM C495 for:
 - a. Mix design compressive strength.
 - b. Mix design wet and dry density range.
 - c. Number of Tests:
 - 1) One per 5,000 square feet.
 - 2) Not less than one for each day's Work.
4. Test EPS insulation board for density in accordance with ASTM C578.

3.18 TESTING OF ROOFING

- A. Inspection and Observation Services (As required):
 1. Inspection of roof deck prior to start of Work.
 2. Inspect on site condition of stored roofing materials.
 3. Inspection during roofing, roof insulation, and sheet metal Work to ascertain compliance with Contract Documents.
 4. Observation of roof test cuts performed by Contractor to ascertain that they are properly made.
 5. Observation of patching of roof test cuts to ascertain that they are properly made.
- B. Testing Services (As required):
 1. Perform dissection and analysis on cuts provided by Contractor to confirm number of plies, bonding of plies, weight of bitumen and softening temperature to ascertain compliance with specifications.

3.19 MASONRY

- A. Inspection and Observation Services:
 1. Inspection of placement of reinforcement including condition, grade, size, location, spacing, and lap splices.
 2. Review mortar design mixes.
 3. Inspection of laying, mortaring, and grouting of concrete masonry units and elements.
- B. Testing Services:
 1. References (As applicable for tests required):
 - a. ASTM International (ASTM)
 - 1) C140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units.
 - 2) C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 3) C1019 - Standard Test Method for Sampling and Testing Grout.
 2. Testing of Concrete Masonry Units (CMU):
 - a. Preconstruction: Perform the following tests in accordance with ASTM C140.
 - 1) Compressive Strength

- 2) Absorption
 - 3) Weight
 - 4) Moisture Content
 - 5) Dimensions.
3. Mortar Tests:
 - a. Preconstruction: Perform the following tests in accordance with ASTM C780 on each type of mortar mix used on the Project.
 - b. 28 Day Compressive Strength
 - c. Water Retention
 - d. Construction: Perform 28 day compressive strength test in accordance with ASTM C780 on each type of mortar mix used on the Project at the rate of one test per 2,000 square feet of masonry.
4. Refer to and include Work for reinforcing steel specified.
5. Grout Tests:
 - a. Preconstruction: Perform the following tests in accordance with ASTM C1019 on each type of grout mix used on the Project.
 - 1) 28 Day Compressive Strength
 - 2) Construction: Perform 28 day compressive strength test in accordance with ASTM C1019 on each type of grout mix used on the Project at the rate of one (1) test per 2,000 square feet of masonry.
 - 3) Prism Test: Perform preconstruction 28 day compressive strength test on concrete masonry walls in accordance with ASTM E447-97, Method B.

3.20 REPAIR AND PROTECTION

- A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 29.
- B. Protect construction exposed by or for quality control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION 01 45 23

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements for temporary utilities, support facilities, and security and protection facilities, including but not limited to:
 - 1. Water service and distribution.
 - 2. Sanitary facilities, including toilets, wash facilities, and drinking water facilities.
 - 3. Heating and cooling facilities.
 - 4. Ventilation.
 - 5. Electric power service.
 - 6. Lighting.
 - 7. Telephone service.
 - 8. Waste disposal facilities.
 - 9. Field office.
 - 10. Storage and fabrication sheds.
 - 11. Lifts and hoists.
 - 12. Construction aids and miscellaneous services and facilities.
 - 13. Environmental protection.
 - 14. Pest control.
 - 15. Enclosure fence.
 - 16. Security enclosure and lockup.
 - 17. Barricades, warning signs, and lights.
 - 18. Temporary partitions.
 - 19. Fire protection.
 - 20. Accessories necessary for a complete installation.

1.3 USE CHARGES

- A. Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service: Pay sewer service use charges for water used and sewer usage by all entities for construction operations.
- C. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.4 SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Moisture Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 2. Indicate procedures for discarding water damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged work.
 3. Indicate sequencing of Work that requires water, such as sprayed fire resistive materials, plastering, and tile grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- C. Dust and HVAC Control Plan: Submit coordination drawing and narrative that indicates the dust and HVAC control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
1. HVAC system isolation schematic drawing.
 2. Location of proposed air-filtration system discharge.
 3. Waste handling procedures.
 4. Other dust control measures.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board ADA-ABA Accessibility Guidelines (ADAAG), ICC/ANSI A117.1, and Texas Accessibility Standards (TAS) 2012.
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Architect. Provide materials suitable for use intended.
- B. Chain Link Fencing: Minimum 2 inch (50 mm), 0.148 inch (3.8 mm) thick, galvanized steel, chain link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8 inch (60 mm) OD line posts and 2-7/8 inch (73 mm) OD corner and pull posts.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10 mils (0.25 mm) minimum thickness, with flame spread rating of 15 or less per ASTM E 84.
- D. Dust Control Adhesive Surface Walk off Mats: Provide mats minimum 36 inches by 60 inches (914 mm by 1624 mm).
- E. Insulation: Unfaced mineral fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame spread and smoke developed indexes of 25 and 50, respectively.

- F. Lumber and Plywood: Comply with requirements in Section 06 10 53.
- G. Gypsum Board: Minimum 1/2 inch (12.7 mm) thick by 48 inches (1219 mm) wide by maximum available lengths; Type X or Type C panels with tapered edges. Comply with Section 09 29 00.
- H. Paint: Comply with requirements in Section 09 90 00.
- I. Tarpaulins: Fire resistive labeled with flame-spread rating of 15 or less.
- J. Water: Potable.

2.2 TEMPORARY FACILITIES

- A. Contractor's Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Provide elevated, stabilized concrete walkway from parking area to field offices.
- B. Architect's Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Provide elevated, stabilized concrete walkway from parking area to field offices.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. Air Filtration Units: HEPA primary and secondary filter equipped portable units with four stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.
- C. Drinking Water: Containerized, tap dispenser, bottled water drinking water units, including paper cup supply. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 degrees F to 55 degrees F (7.2 degrees C to 12.7 degrees C).
- D. Electrical Outlets: Properly configured, NEMA polarized outlets to prevent insertion of 110V to 120V plugs into higher voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.
- E. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.
- F. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid propane gas or fuel oil heaters with individual space thermostatic control.
 - 1. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 2. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of **8** at each return air grille in system and remove at end of construction. Clean HVAC system as required in Section 01 77 00 and install new filter with MERV 11 or greater.
- G. Air Filtration Units: Primary and secondary HEPA filter equipped portable units with four stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate facilities where they will serve project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 01 10 00.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. Install temporary service. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
 - 2. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
- E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing Work, isolate the HVAC system in area where Work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in Work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within Work area using HEPA equipped air filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust producing equipment. Isolate limited Work within occupied areas using portable dust containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA filter equipped vacuum equipment.
- G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Install electric power service underground unless otherwise indicated.
 1. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment.
 - a. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length voltage ratio.
 - b. Provide warning signs at power outlets other than 110 to 120 V.
 - c. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or traffic areas.
 - d. Provide metal conduit enclosures or boxes for wiring devices.
 - e. Provide 4 gang outlets, spaced so 100 foot (30 m) extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 2. Install lighting for Project identification sign.
- J. Telephone Service: Provide temporary telephone service in common use facilities for use by construction personnel. Install one telephone line(s) for each field office.
 1. Provide dedicated telephone line for each facsimile machine in each field office.
 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.
 3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- K. Electronic Communication Service: Provide a desktop computer and printer/scanner in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications.
 1. Provide high speed wireless internet access (provide access to the Owner and Architect); DSL or broadband. Dial-up connection is not acceptable.
 2. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall.
 3. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 4. Backup: External hard drive, minimum 1 terabyte, with automated backup software providing daily backups.

3.3 SUPPORT FACILITIES INSTALLATION

- A. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.

TEMPORARY FACILITIES AND CONTROLS

1. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 20 00.
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 4. Delay installation of final course of permanent pavement until immediately before Substantial Completion.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary parking areas for construction personnel.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.
- F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 3. Maintain and touchup signs so they are legible at all times.
- G. Waste Disposal Facilities: Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300.
- H. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Temporary Elevator Use: Use of elevators is not permitted.
- J. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities to the satisfaction of Owner and Architect.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant protection zones.
 - 2. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.
- G. Site Enclosure Fence: Before construction operations begin. Provide site enclosure fence to prevent people and animals from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each Work day.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

- L. Temporary Partitions: Provide floor to ceiling dustproof partitions to limit dust and dirt migration and to separate occupied areas occupied from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire retardant treated plywood on construction operations side.
 - 2. Construct dustproof partitions with two layers of 6 mil (0.14 mm) polyethylene sheet on each side. Cover floor with two layers of 6 mil (0.14 mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire retardant treated plywood. Do not apply tape to finish floor surfaces.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water dampened foot mats in vestibule.
 - 3. Where fire resistance rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 4. Insulate partitions to control noise transmission to occupied areas.
 - 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 6. Protect air handling equipment.
 - 7. Provide walk off mats at each entrance through temporary partition.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas.
 - 2. Supervise welding operations, combustion type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture Protection Plan: Avoid trapping water in finished Work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 - 1. Protect porous materials from water damage.
 - 2. Protect stored and installed material from flowing or standing water.
 - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 - 4. Remove standing water from decks.
 - 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 - 2. Keep interior spaces reasonably clean and protected from water damage.
 - 3. Periodically collect and remove waste containing cellulose or other organic matter.
 - 4. Discard or replace water-damaged material.
 - 5. Do not install material that is wet.
 - 6. Discard, replace, or clean stored or installed material that begins to grow mold.

7. Perform Work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Condition Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits and moisture control.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum based products, which become wet during the course of construction and remain wet for 48 hours are considered defective and are to be removed and replaced.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24 hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion unless otherwise required and approved by Owner and Architect.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00"

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for selection of products, including but not limited to:
 - 1. Product delivery, storage, and handling.
 - 2. Manufacturers' written warranties on products.
 - 3. Special warranties.
 - 4. Comparable products.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term *product* includes the terms *material*, *equipment*, *system*, *assembly*, and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis of Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words *basis of design product*, including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the specified requirements.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00.

- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis of Design Product Specification Submittal: Comply with requirements in Section 01 33 00. Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long term storage at site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.
 - 7. Provide a secure location and enclosure at site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

- B. Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 2. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and items needed for complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected", Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 3. Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 5. Basis of Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and characteristics based on the product named. Comply with requirements for consideration of an unnamed product by one of the named manufacturers.
- C. Visual Matching Specification: Where Specifications require "*match Architect's sample*", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - 1. If no product available within specified category matches and complies with specified requirements, comply with requirements of Section 01 25 00 for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "*selected by Architect*" or similar phrase, select a product that complies with requirements. Architect will select color,

gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair Work required to restore construction to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- C. Certified Surveys: Submit two copies signed by land surveyor.
- D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor legally qualified to practice in the State of Texas, who is experienced in providing land surveying services of the kind indicated.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.

- B. In Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not warranted. Before beginning site Work, investigate and verify existence and location of underground utilities, mechanical and electrical systems, and construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping; underground electrical services, and other utilities.
 - 2. Furnish location data for Work related to the Work that must be performed by public utilities serving the site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation after correcting unsatisfactory conditions. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 01 31 00.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as necessary to locate each element of Project.
 - 2. Establish limits on use of site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical Work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control Work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other Work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor or professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical Work plumb and make horizontal Work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions ensuring the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.

3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous. Materials containing asbestos and BCPs are prohibited.

3.6 OWNER INSTALLED PRODUCTS

- A. Site Access: Provide access to site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with Work performed by Owner's construction personnel.
 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's Work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. Clean site and Work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 degrees F (27 degrees C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 50 00.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with mechanical, plumbing, and electrical requirements.
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 01 73 00

SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Procedural requirements for cutting and patching.

1.3 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair Work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 - 2. Changes to In Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 - 3. Products: List products used for patching and firms or entities that will perform patching Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.5 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
- B. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- C. Operational Elements: Do not cut and patch operating elements and related components that results in reducing the capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 - 1. Primary operational systems and equipment.
 - 2. Fire separation assemblies.
 - 3. Air or smoke barriers.
 - 4. Fire suppression systems.
 - 5. Mechanical systems piping and ducts.

6. Control systems.
 7. Communication systems.
 8. Fire-detection and -alarm systems.
 9. Conveying systems.
 10. Electrical wiring systems.
 11. Operating systems of special construction.
- D. Miscellaneous Elements: Do not cut and patch the following elements or related components that change the load bearing capacity, resulting in a reduction of capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
1. Water, moisture, or vapor barriers.
 2. Membranes and flashings.
 3. Exterior curtain wall construction.
 4. Equipment supports.
 5. Piping, ductwork, vessels, and equipment.
 6. Noise and vibration control elements and systems.
 7. Sprayed fire resistive material.
- E. Visual Requirements: Do not cut and patch construction resulting in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
1. If possible, retain original Installer or fabricator to cut and patch exposed Work. If possible, engage original Installer or fabricator. If original installer is not available, engage recognized, experienced, and specialized firm for the Work.
 - a. Processed concrete finishes.
 - b. Ornamental metal.
 - c. Matched veneer woodwork.
 - d. Preformed metal panels.
 - e. Roofing.
 - f. Firestopping.
 - g. Window system.
 - h. Fluid applied flooring.
 - i. Wall covering.
 - j. HVAC enclosures, cabinets, or covers.
- F. Cutting and Patching Conference: Before proceeding, meet at site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with specified requirements.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where removal, relocation, or abandonment is necessary, bypass existing services before cutting to avoid interruption of services to occupied areas.

3.3 CUTTING AND PATCHING

- A. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at earliest feasible time, and complete without delay.
 - 1. Cut existing construction to provide for installation of components or performance of construction, and subsequently patch as necessary to restore surfaces to an original condition.
 - 2. Cut in place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Temporary Support: Provide temporary support of Work to be cut.
- C. Protection: Protect in place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- D. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00.
- E. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. Use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable earthwork specifications by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction to eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions are removed, extend one finished area into another, patch and repair surfaces in new space. Provide even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance.
 4. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 5. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
 6. Exterior Building Enclosure: Patch components and restore enclosure to a weathertight condition.

END OF SECTION 01 73 29

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 PRE-CLOSEOUT MEETING

- A. Pre-Closeout Meeting: Schedule and convene Pre-Closeout Meeting with Owner and Architect in accordance with Section 01 31 00, Project Coordination and Management.

1.3 SUBSTANTIAL COMPLETION

- A. The items listed in the Supplementary Conditions, Paragraph 9.8 and the following items shall be completed before Substantial Completion will be granted:
 - 1. Contractor's Completion List (Punch List): Submit a thorough list of items to be completed or corrected, along with a written request for Substantial Completion and for review of the Work or portion of the Work. The Architect/Engineer's Project Representative, at their discretion, may attend and assist in the preparation of the Contractor's Punch List.
 - 2. Architect's Supplemental Punch List: The Architect/Engineer, along with the Owner at the Owner's discretion, will inspect the Work utilizing the Contractor's prepared Punch List, noting completed items and incomplete items, and will prepare a supplemental list of items that have been omitted or incomplete items that were not previously noted.
 - 3. Operations and Maintenance Manuals: Submit as described in paragraph 1.3.
 - 4. Final Cleaning: Provide final cleaning and adequate protection of installed construction as described in paragraph 1.6 and 1.7.
 - 5. Starting of systems: Start up equipment and systems as described in paragraph 1.8.
 - 6. Testing and balancing: Testing and balancing of systems must be performed and completed by Owner's forces, and the report submitted and accepted by Architect/Engineer and Owner, as described in the Contract Documents. Make adjustments to equipment as required to achieve acceptance.
 - 7. Demonstrations: If required by individual specification sections or by Owner, provide demonstrations and instructions for use of equipment as described in paragraph 1.9.
- B. Date of Substantial Completion: Complete or correct items identified on Punch List and confirm that all items have been corrected prior to Architects re-inspection. Architect/Engineer, along with the Owner, will re-inspect the corrected work to establish the Date of Substantial Completion. Incomplete items remaining will be appended to the Certificate of Substantial Completion (AIA G704). The Date of Substantial Completion represents day one (1) of the closeout period, and represents the date of commencement of the Contractors correctional period and all warranty periods as described and required by the Contract Documents, except as amended in the Certificate of Substantial Completion and elsewhere in the Contract Documents.
- C. Certificate of Substantial Completion: When the Work or designated portion thereof is substantially complete, Architect will prepare the Certificate of Substantial Completion to be executed by the Owner and Contractor. Items on the appended Punch List shall be completed or corrected within the time limits established in the Certificate.

1.4 PUNCH LIST

- A. A comprehensive list prepared by the Contractor prior to Substantial Completion, and attached thereto, to establish all items to be corrected, or limited items of work to be completed, if any. This list is intended to represent a limited number of items needing attention.
- B. Punch lists shall be furnished to the Architect in Microsoft Excel and PDF formats. The punch list shall be in matrix form and shall include the following information for each punch list item:
 - 1. Room number or other suitable location identifier
 - 2. Description of the work
 - 3. Sub-contractor/trade sign-off that the work has been verified to be 100% complete and in accordance with the Contract Documents
 - 4. Sub-contractor/trade sign-off date
 - 5. General contractor sign-off that the work has been verified to be 100% complete and in accordance with the Contract Documents
 - 6. General contractor/trade sign-off date
 - 7. A/E consultant sign-off
 - 8. A/E consultant sign-off date
 - 9. If requested by the Owner, provide two additional similar columns for their sign-off.
 - 10. In the case of excessive repetition of the same item at various locations, the punch list may contain "general notes/items" that shall be applied to the entire project; and it shall be the responsibility of the contractor/sub-contractor to thoroughly examine the entire project and make corrective measures at all applicable locations.
- C. Should the Architect determine that the Contractor's punch list lacks sufficient detail or requires extensive supplementation, the punch list will be returned to the Contractor for re-inspection and revision. The date of Substantial Completion will be delayed until the punch list submitted is a reasonable representation of the work to be done.
- D. A significantly large number of items to be completed or corrected will preclude the Architect from issuing a Certificate of Substantial Completion. The Owner and Architect will be the sole judge of what constitutes a significantly large number of items. It is anticipated that the detailed list of items of work to be completed or corrected at the Date of Substantial Completion will be no longer than five (5) typed pages.
- E. The Contractor's superintendent shall participate in the preparation of the Contractor's punch list that is submitted to the Architect and Owner for supplementation. Upon receipt, the Architect and Consultants shall perform a spot review to determine the adequacy and completeness of the Contractor's punch list.
- F. Upon receipt of an acceptable Contractor's punch list, the Contractor's Superintendent shall accompany the Architect, his Consultants and the Owner (at his discretion) during their observation and the preparation of their supplements to the Contractor's punch list.
 - 1. The Superintendent shall record or otherwise take note of all supplementary items.
 - 2. The Architect will endeavor to furnish to the Contractor typed, hand written or recorded supplements to the punch list in a prompt manner; however, any delay in the Contractor's receiving said supplements from the Architect will not be cause for a claim for additional cost or extension of time as the Contractor's Superintendent shall have been in attendance during the inspections of the Architect and his Consultants and will have been expected to take his own notes.

1.5 OPERATIONS AND MAINTENANCE MANUAL

- A. As a requirement for Substantial Completion, the final Operation and Maintenance Manual shall be submitted to, and reviewed and accepted by the Architect prior to issuance of the Certificate.
- B. Prepare 3-ring D-slant binder cover and spline with printed title "OPERATIONS AND MAINTENANCE MANUAL", title of project, and subject matter of binder when multiple binders are required.
- C. Submit one (1) copy of preliminary Operations and Maintenance Manuals to respective consultants (Civil, MEP, Structural, etc.) for review of conformance with contract requirements prior to submitting final to Architect. Allow time for proper review.
- D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- F. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and Maintenance, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Equipment start-up instructions
 - e. Operating instructions.
 - f. Maintenance instructions for equipment and systems.
 - g. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Product data.
 - b. Air and water balance reports.
 - c. Photocopies of warranties, certificates and bonds. Submit originals with Closeout Documents as specified below.
- G. Submit one (1) final original and two (2) copies to Architect.
- H. Contractor shall provide a DVD, in PDF Format, the following documents after approval by the Architect, Consultants and Owner: closeout manual, MSDS binder, O&M Manuals, specifications and approved submittals. Documents shall be hyper-linked to the Table of Contents.

1.4 PROJECT CLOSEOUT

- A. Final Payment will not be authorized by the Architect until the Architect finds the Work acceptable under the Contract Documents, subject to the completion and acceptance of the following requirements and other applicable Contract requirements:
 - 1. Close-out Documents: Provide bound closeout documents as described in paragraph 1.5. Refer to the Supplementary Conditions, Paragraph 9.10 for additional information.
 - 2. Record Documents: Submit as described in paragraph 1.10.

3. Extra materials: Provide extra stock, materials, and products as described in paragraph 1.11 when required by individual specification sections.
4. Locks: Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
5. Temporary Facilities: Discontinue and remove temporary facilities from the site, along with mockups, construction aids, and similar elements.
6. Warranties, Certificates and Bonds: Execute and assemble transferable warranty documents, certificates, and bonds from subcontractors, suppliers, and manufacturers as described in paragraph 1.12.
7. Final Inspection and Acceptance by Architect is achieved as described in paragraph 1.13.

1.5 CLOSEOUT DOCUMENTS

- A. Coordinate the following items with the requirements of Document CB, Supplementary Conditions of the Contract.
- B. Prepare 3-ring D-slant binder cover and spline with printed title "CLOSEOUT DOCUMENTS", title of project, and subject matter of binder when multiple binders are required. Submit one (1) original and two (2) copies.
- C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. The close-out documents shall be neatly organized and easily useable as determined by the Architect and Owner. Separate Close-out Documents binders from Operations and Maintenance Manuals. Documents identified as "affidavit" shall be notarized.
- E. Contents: Prepare Table of Contents for each volume, with each item description identified, typed on white paper, in five (5) parts as follows:
 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers. All General Contractor's vendors/suppliers and subcontractors that provided materials or performed any work related to this project must be listed on this form. Submit Final List of Subcontractors on Document AD.
 2. Part 2: Closeout Documents and Affidavits, include the following:
 - a. AIA G707 - Consent of Surety to Final Payment;
 - b. AIA G706 - Contractor's Affidavit of Payment of Debts and Claims;
 - c. AIA G706A - Contractor's Affidavit of Release of Liens;
 3. Part 3: Project documents and certificates, including the following:
 - a. Copy of Certificate of Substantial Completion (AIA G704);
 - b. Copy of All Permits;
 - c. Copy of Final Utility Bill or letter of transfer;
 - d. Copy of Certificate of Occupancy;
 - e. Copy of Certification of Project Compliance: Submit on attached **Close-out Form "B"**. Owner and Architect will initiate form and forward to Contractor for signature once Substantial Completion is established. (Owner to be provided original separately);
 4. Part 4: Warranties, Release of Liens, compile sequentially based on specification sections:
 - a. General Contractor's Warranty: Submit on company letterhead as described below. This Warranty shall state all sections of Work performed by General Contractor's own forces, and warranty period for each section of Work;

- b. Subcontractor's Release of Lien: Include contractor's, subcontractor's and direct material and equipment supplier's separate final releases. Submit on attached **Close-out Form "A"** – Subcontractor's Affidavit of Release of Lien.
 - c. Hazardous Material Certificate: Submit on attached **Close-out Form "C"**. Affidavits from Contractor, Subcontractors and General Contractor's vendors or suppliers stating that no hazardous materials/products have been used or installed in this project.
 - d. Subcontractor's Warranty: notarized, and submitted on attached **Close-out Form "D"**. This Warranty shall state all sections of Work performed by the subcontractor and warranty period.
 - e. Special / Extended Warranties; List and provide, notarized warranties requested by Owner, or required by or incorporated in the Contract Documents.
 - f. Spreadsheet depicting all items and materials that carry a warranty longer than one (1) year. Include information consisting of material/ supplier/ installer/ specification section/ length of warranty and contact information.
5. Part 5: Receipts:
- a. Extra Stock: Provide original receipts for delivery of "Extra Stock" items as described below. Receipts must be signed by an authorized Owner's representative;
 - b. Keys: Provide original receipts for delivery of "Keys". Receipts must be signed by an authorized Owner's representative.
 - c. Sign in sheets: provide signatures of attendees from all demonstrations.
- F. In addition to the three (3) required close-out binders listed above, provide Architect with one (1) separate binder for their records containing the following:
- 1. Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers;
 - 2. All MSDS sheets for the project;
 - 3. All warranties from Contractor, subcontractors, direct suppliers, and manufacturers.
- G. Failure to complete and close-out project after substantial completion may result in liquidated damages being assessed to the Contractor. Refer to Conditions of the Contract for additional requirements and liquidated damages.

1.6 FINAL CLEANING

- A. Execute final cleaning prior to final project inspection and acceptance.
- B. Clean interior and exterior glass, and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces, mop hard floor surfaces.
- C. Remove smudges, marks, stains, fingerprints, soil, dirt, spots, dust, lint, and other foreign materials from finished and exposed surfaces
- D. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- E. Clean and replace filters of operating equipment as required by Contract Documents
- F. Clean debris from roofs, gutters, downspouts, and drainage systems.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste and surplus materials, rubbish, and temporary construction facilities from site.

1.7 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections until Work is accepted by Architect and Owner.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

1.8 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer and Owner 48 hours prior to start-up of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of Contractors' personnel, and installer in accordance with manufacturers' instructions.
- G. When specified in individual specification sections or required by manufacturer, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. When specified in individual specification sections or required by Owner or Architect/Engineer, submit a written report in accordance with Section 01 33 00, Submittal Procedures, that equipment or system has been properly installed and is functioning correctly.

1.9 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel a minimum of 48 hours prior to date of Final Completion in accordance with Owner's requirements.
- B. Demonstrate Project equipment instructed by qualified manufacturer's representative who is knowledgeable about the Project and equipment.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.

- D. Utilize maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment.
- F. Prepare and insert additional data in maintenance manuals when need for additional data becomes apparent during instruction.
- G. Review and verify proper start-up and operation of equipment prior to scheduling demonstrations with Owner.
- H. All demonstrations are to be documented by video and submitted to the Owner in DVD format along with the close out documents. General contractor is responsible for all video and compilation onto DVD with linked menus.

1.10 PROJECT RECORD DOCUMENTS

- A. Project Record Documents, as described in Section 01 78 39, shall be submitted at Project Closeout. Final Payment will not be authorized by the Architect until final review and acceptance by Architect and Engineers is achieved in accordance with the Owners requirements.
- B. At the Contractors request, and with associated fee, Architect may provide electronic versions of the construction drawing and specification files for Contractors use, subject to the terms and conditions of Architects standard electronic document transfer agreement.
- C. Submit reproducible to respective consultants (Civil, Structural, MEP, etc.) for review. Consultant will mark-up corrections and return to Contractor for final revisions. Make final revisions prior to submitting to Architect.
 - 1. Format: One (1) set of film positive reproducibles and two (2) sets bluelines of approved reproducibles.
 - 2. Provide the Owner with one (1) set of Record Drawings on a non-rewritable CD in AutoCAD® latest release.
 - 3. Provide the Owner with one (1) set of Record Drawings on a on a non-rewritable CD in PDF format.
 - 4. Label electronic CAD files and PDF files in the same manner as the sheets (example, A2.02 First Floor Area 'A', etc.)

1.11 EXTRA STOCK, MATERIALS AND MAINTENANCE PRODUCTS

- A. Furnish extra stock, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site or to District Maintenance Department as directed by Owner; obtain signed receipt from Owner's authorized representative prior to final application for payment. Delivery of materials to, or obtaining receipt from anyone other than Owner's authorized representative may constitute breach of this requirement and may require delivery of additional materials at no cost to the Owner if original materials are misplaced.
- C. Include signed receipts for delivery of extra stock and materials, including keys, with Closeout Documents.

1.12 WARRANTIES, CERTIFICATES AND BONDS

- A. Definitions:

1. Standard Product Warranties: preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
 2. Special Warranties: written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide coverage of specific defects, or both.
- B. In accordance with the general warranty obligations under Paragraph 3.5 of the General Conditions as amended by the Supplementary Conditions, the General Contractor's warranty shall be for a period of one (1) year following the date of Substantial Completion, hereinafter called the one-year warranty period. The Contractor's one-year general warranty shall include all labor, material and delivery costs required to correct defective material and installation. This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.
- C. The Contractor's one-year warranty shall run concurrently with the one (1) year period for correction of Work required under Paragraph 12.2 of the General Conditions.
- D. No service charges or call out charges are allowed to investigate warranty claims.
- E. In addition to the Contractor's one-year warranty, Special Warranties as described in individual specifications sections, shall extend the warranty period for the period specified without limitation in respect to other obligations which the Contractor has under the Contract Documents.
- F. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve the suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- G. Warranty Requirements:
1. When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
 2. When Work covered by a warranty has failed and been corrected by replacement or reconstruction, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
 3. Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
 4. Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 5. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or designated portion of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- H. Compile copies of each required warranty properly executed by the Contractor and the subcontractor, supplier, or manufacturer. Verify documents are in proper form, contain full information, and are notarized. Co-execute warranties, certificates and bonds when required and include signed warranties with Closeout Documents submitted to the Architect.

1.13 FINAL COMPLETION AND FINAL PAYMENT

- A. Final Notice and Inspection:

1. When all items on the Punch List have been corrected, final cleaning has been completed, and installed work has been protected, submit written notice to the Architect that the Work is ready for final inspection and acceptance.
 2. Upon receipt of written notice that the Work is ready for final inspection and acceptance, the Architect and Engineer will make final inspection.
- B. Final Change Order: When the Project Closeout items described above are successfully completed and the Work is found acceptable to Architect/Engineer and Owner, a Final Change Order will be executed. This Change Order will include any Allowance adjustments as required by the Contract Documents.
- C. Final Application for Payment: When all of the above items are successfully complete, submit to the Architect a final Application for Payment and request for release of retainage.
- D. Release of Retainage: Release of retainage will not be authorized by the Architect until Contractor completes all requirements for close-out to the satisfaction of the Owner and Architect as described herein.

1.14 TERMINAL INSPECTION

- A. Immediately prior to expiration of the one (1) year period for correction of the Work, the Contractor shall make an inspection of the work in the company of the Architect and the Owner. The Architect and the Owner shall be given not less than ten (10) days notice prior to the anticipated date of terminal inspection.
- B. Where any portion of the work has proven to be defective and requires replacement, repair or adjustment, the Contractor shall immediately provide materials and labor necessary to remedy such defective work and shall execute such work without delay until completed to the satisfaction of the Architect and the Owner, even if the date of completion of the corrective work may extend beyond the expiration date of the correction period.
- C. The Contractor shall not be responsible for correction of work which has been damaged because of neglect or abuse by the Owner nor the replacement of parts necessitated by normal wear in use.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 77 00

SECTION 01 77 00 CLOSEOUT FORMS

CLOSE-OUT FORM "A"

SUBCONTRACTOR'S AFFIDAVIT OF RELEASE OF LIEN

STATE OF _____

COUNTY OF _____

KNOW ALL MEN BY THESE PRESENTS:

_____, being first duly sworn, deposes and says:

1. That he / she is the _____ of _____, the subcontractor who supplied, installed, and /or erected the work described below, and that, he /she is duly authorized to make this Affidavit and Subcontractor Release:

Project: PSJA ISD New Swimming Facilities

Owner: Pharr-San Juan- Alamo ISD

Architect: PBK

Work Performed: _____ Specification Section(s): _____

2. That all work required under the subject subcontractor of the subject construction project has been performed in accordance with the terms thereof, that all material men, sub-subcontractors, mechanics, and laborers have been paid and satisfied in full and that there are no outstanding claims of any character arising out of the performance of said subcontractor which have not been paid and satisfied in full.
3. That to the best of his / her knowledge and belief, there are no unsatisfied claims for damages resulting from injury or death to any employees, sub-subcontractors, or the public at large arising out of the performance of said subcontract, or any suits or claims for any other damages of any kind, nature, or description which might constitute a lien upon the property of the Owner.
4. That he / she has received full payment of all sums due him / her for materials furnished and services rendered by the undersigned in connection with the performance of said subcontract and has and does hereby release the Owner and the Architect and his consultants and the Contractor from any and all claims of any character arising out of or in any way connected with performance of said subcontract.

ATTEST (If Corporation)

Name of Subcontractor

Secretary

(By)

(Title)

JURAT

STATE OF _____

COUNTY OF _____

Sworn to and subscribed before me on this _____ day of _____, 20_____.

(Seal)

(Notary Public Signature)

CLOSE OUT FORM "B"

**CERTIFICATION
OF PROJECT
COMPLIANCE**

Completion of this form is required under the provisions of §61.1036(c)(3)(F) TAC for all public school district construction projects. Instructions for completion of this form can be found on page 2.

1. PROJECT INFORMATION

Facility:

Address:

City:

DISTRICT:

ARCHITECT/ENGINEER:

CONTRACTOR/CM:

CONTRACT DATE:

DATE DISTRICT AUTHORIZED PROJECT:

BRIEF DESCRIPTION OF PROJECT:

2. CERTIFICATION OF DESIGN AND CONSTRUCTION

The intent of this document is to assure that the school district has provided to the architect/engineer the required information and the architect/engineer has reviewed the School Facilities Standards as required by the State of Texas, and used his/her reasonable professional judgment and care in the architectural/engineering design and that the contractor has constructed the project in a quality manner in general conformance with the design requirements and that the school district certifies to project completion.

3. The District certifies that the educational program and the educational specifications of this facility along with the identified building code to be used have been provided to the architect/engineer.

DISTRICT:

BY:

DATE:

4. The Architect/Engineer certifies the above information was received from the school district, and that the building(s) were designed in accordance with the applicable building codes. Further, the facility has been designed to meet or exceed the design criteria relating to space (minimum square footage), educational adequacy, and construction quality as contained in the School Facilities Standards as adopted by the Commissioner of Education, June 9, 2003, and as provided by the district.

ARCHITECT/ENGINEER:

BY:

DATE:

5. The Contractor/CM certifies that this project has been constructed in general conformance with the construction documents as prepared by the architect/engineer listed above.

CONTRACTOR/CM:

BY:

DATE:

6. The District certifies completion of the project (as defined by the architect/engineer and contractor).

DISTRICT:

BY:

DATE:

INSTRUCTIONS FOR COMPLETION OF "CERTIFICATION OF PROJECT COMPLIANCE" FORM

Section 1. Identify the following:

- name and address of the school facility
- name of the school district
- the Architect/Engineer and Contractor
- the date of execution of the construction contract
- the date that the school district authorized the superintendent to hire an architect/engineer
- scope of the project.

Section 2. This section outlines the intent of the document. No action required.

Section 3. This section is to be executed by the school district upon transmittal of the information (as listed) to the architect/engineer and is to remain in the custody of the school district throughout the entire project.

Section 4. This section is to be executed by the architect/engineer upon completion of the plans and specifications and in conjunction with the completion of the plan review for code compliance (ref. 19 TAC §61.1033 or §61.1036, School Facilities Standards) and returned to the school district's files.

Section 5. This section is to be executed by the contractor upon substantial completion of the project and retained in the school district's files.

Section 6. This section is to be executed by the school district upon acceptance and occupancy of the project.

NOTE: DO NOT SUBMIT THIS DOCUMENT TO THE TEXAS EDUCATION AGENCY. The school district will retain this document in their files indefinitely until review and/or submittal is required by representatives of the Texas Education Agency.

CLOSE-OUT FORM "C"

SUBCONTRACTOR HAZARDOUS MATERIAL CERTIFICATE

THE STATE OF _____ PROJECT: PSJA ISD New Swimming Facilities
COUNTY OF _____ OWNER: Pharr-San Juan-Alamo Independent School District
ARCHITECT: PBK
SPECIFICATION SECTION(S):

KNOW ALL MEN BY THESE PRESENTS:

_____, being first duly sworn, deposes and says that he / she
is the _____ of _____, the subcontractor / supplier who
constructed or provided the section(s) of work referenced above, and that he / she is duly authorized to
certify to the best of his / her information, knowledge, and belief no asbestos, lead or PCB containing
products have been incorporated into the project.

ATTEST (If Corporation)

Name of Subcontractor / Supplier

(Title)

Secretary (By)

JURAT

THE STATE OF _____

COUNTY OF _____

Sworn to and subscribed before me on this _____ day of _____, 20____.

(Seal)

(Notary Public Signature)

CLOSE-OUT FORM "D"

SUBCONTRACTOR WARRANTY

STATE OF _____

COUNTY OF _____

KNOW ALL MEN BY THESE PRESENTS:

_____, being first duly sworn, deposes and says:

1. That he / she is the Subcontractor (or the _____ of _____ the subcontractor) who supplied, installed, and / or erected the work described below, and that, he / she is duly authorized to make this Subcontractor Warranty:

Project: PSJA ISD New Swimming Facilities

Owner: Pharr-San Juan-Alamo

Architect: PBK

Work Performed: _____

Specification Section(s): _____

2. The undersigned Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract are of good quality and new except where otherwise required or permitted by the Contract Documents, that the Work is free from defects not inherent in the quality required or permitted, and that the Work conforms with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Subcontractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Subcontractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.
3. In the event of failure of materials, products, or workmanship, during the specified warranty periods, the Subcontractor shall take appropriate measures to assure correction or replacement of the defective items, whether notified by the Contractor, Owner or Architect.
4. The Subcontractor warrants the work performed for a period of _____ months from the date of Substantial Completion, except as follows: _____

ATTEST (If Corporation)

Name of Subcontractor

Secretary

(By)

(Title)

JURAT

STATE OF _____

COUNTY OF _____

Sworn to and subscribed before me on this _____ day of _____, 20____.

(Seal)

(Notary Public Signature)

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for project record documents, including but not limited to:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings:
 - 1. Number of Copies: Submit one set of marked up record prints.
 - 2. Number of Copies: Submit copies of record Drawings:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one of file prints.
 - 2) Submit record digital data files and one sets of plots.
 - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and three sets of prints.
 - 2) Submit record digital data files and three sets of record digital data file plots.
 - 3) Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit one paper copy and one annotated PDF electronic file of the Project Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one paper copy and one annotated PDF electronic file and directory of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: Refer to the individual Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Submit one paper copy and annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report monthly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 PROJECT RECORD DOCUMENT PROCEDURES

- A. Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference.
 - 1. Do not use As Built Drawings and Specifications for Record Drawings and Specifications.

- B. Recording Procedures: Update drawings and specifications on daily bases to record actual conditions. Record information concurrently with construction progress. Do not conceal Work until required information is accurately recorded.
- C. Store Record Documents and samples apart from as built documents used for construction.
 - 1. Label and file Record Documents and samples in accordance with section number listings in Table of Contents. Label each document *PROJECT RECORD* in neat, large, printed letters.
 - 2. Maintain Record Documents in clean, dry and legible condition.
 - 3. Make Record Documents and samples available for inspection upon request of Architect.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked up paper copies of the Contract Drawings and Shop Drawings.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked up record prints. Show actual installation conditions where installation varies from that shown originally.
 - a. Give attention to information on concealed elements difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross reference record prints to corresponding shop drawings or archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked up record prints.
 - 4. Mark record sets with erasable, red colored pencil. Use colors to distinguish between changes for different categories of the Work at same location.
 - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked up record prints with Architect. When authorized, prepare full set of corrected digital data files of the Contract Drawings:
 - 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings and annotated PDF electronic file with comment function enabled.
 - 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 - 3. Refer instances of uncertainty to Architect for resolution.
 - 4. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. Refer to Section 01 33 00 for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
 - 1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or modification.
 - 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- D. Format: Identify and date each record Drawing; include the designation *PROJECT RECORD DRAWING* in a prominent location.
 - 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Format: Annotated PDF electronic file with comment function enabled.
 - 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 - 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation PROJECT RECORD DRAWINGS.
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications. Indicate actual product installation where installation varies from that indicated in Specifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.

5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file and marked up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as annotated PDF electronic file. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 RECORD SAMPLES

- A. Record Samples: Determine with Architect and Owner which submitted Samples are to be maintained as Record Samples. Maintain and mark one set to indicate date of review and approval by Architect; note any deviations or variations between reviewed sample and installed product or material.

2.5 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by the individual Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference. Include the following:
 1. Reviewed shop drawings, product data, and samples.
 2. Field test reports.
 3. Inspection certificates and manufacturer's certificates.
 4. Inspections by authorities having jurisdiction (AHJ).
 5. Documentation of foundation depths.
 6. Special measurements or adjustments.
 7. Tests and inspections.
 8. Surveys.
 9. Design mixes.
- B. Format: Submit miscellaneous record submittals as scanned PDF electronic file(s) of marked up miscellaneous record submittals. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.
 - 4. O&M Manuals should be uploaded into Owner's designated software (Prolog)

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules utilizing manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For instructor.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date of video recording.
 - 2. At completion of training, submit complete training manual(s) for Owner's use.

1.5 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.

- e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 2. Owner will furnish Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner through Program Manager with at least 10 days' advance

notice.

- C. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
- B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Architect.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

END OF SECTION 01 79 00

SECTION 031000 CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formwork for cast-in place concrete.
 - 2. Shoring, bracing, and anchorage.
 - 3. Architectural form liners.
 - 4. Form accessories.
 - 5. Form stripping.
- B. Related Sections:
 - 1. Section 032000 - Concrete Reinforcement.
 - 2. Section 033000 - Cast-in-Place Concrete.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications for Structural Concrete.
 - 3. ACI 318 - Building Code Requirements for Structural Concrete.
 - 4. ACI 347 - Guide to Formwork for Concrete.
- B. American Forest and Paper Association:
 - 1. AF&PA - National Design Specifications for Wood Construction.
- C. The Engineered Wood Association:
 - 1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.
- D. ASTM International:
 - 1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- E. West Coast Lumber Inspection Bureau:
 - 1. WCLIB - Standard Grading Rules for West Coast Lumber.

1.3 DESIGN REQUIREMENTS

- A. Design, engineer and construct formwork, shoring and bracing in accordance with ACI 318 to conform to design and applicable code requirements to achieve concrete shape, line and dimension as indicated on Drawings.

1.4 PERFORMANCE REQUIREMENTS

- A. Vapor Retarder Permeance: Maximum .03 perms when tested in accordance with ASTM E96, Procedure A.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 347 ACI 301 ACI 318.
- B. For wood products furnished for work of this Section, comply with AF&PA.
- C. Perform Work in accordance with State Municipality of Highways Public Work's standard.

1.6 COORDINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate this Section with other sections of work, requiring attachment of components to formwork.

PART 2 PRODUCTS

2.1 WOOD FORM MATERIALS

- A. Form Materials: At discretion of Contractor.

2.2 FORMWORK ACCESSORIES

- A. Vapor Retarder: Where indicated on Drawings, 10 mil thick polyethylene sheet manufacture by:
 - 1. Stego Wrap Class A: by Stego Industries LLC (887) 464-7834
 - 2. Griffolyn by Reef Industries (800) 231-6074
 - 3. VaporBlock 10 by Raven Industries (800) 635-3456
 - 4. Perminator Vapor – May by W.R. Meadows (800) 342-5976
 - 5. Xtreme by Tex-Trude (281) 452-5961
 - 6. Or Equivalent
- B. Bituminous Joint Filler: ASTM D1751.
- C. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength and character to maintain formwork in place while placing concrete.
- D. Water Stops: Rubber Polyvinyl chloride, minimum 1,750 psi tensile strength, minimum 50 degrees F to plus 175 degrees F working temperature range, inch wide, maximum possible lengths, ribbed profile, preformed corner sections, heat welded jointing.

***** OR *****

- E. Waterstop: Flexible strip of bentonite waterproofing compound in coil form for joints in concrete construction.
 - 1. Colloid Environmental Technologies Company Model.
 - 2. TC MiraDRi Model.
 - 3. Paramount Technical Products Model.
 - 4. Substitutions: Section 016000 - Product Requirements Not Permitted.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify lines, levels, and centers before proceeding with formwork. Verify dimensions agree with Drawings.
- C. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Architect/Engineer.

3.2 INSTALLATION

- A. Earth Forms:
 - 1. Earth forms are not permitted.
- B. Formwork - General:
 - 1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
 - 2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
 - 3. Camber forms where necessary to produce level finished soffits unless otherwise shown on Drawings.
 - 4. Carefully verify horizontal and vertical positions of forms. Correct misaligned or misplaced forms before placing concrete.
 - 5. Complete wedging and bracing before placing concrete.
- C. Forms for Smooth Finish Concrete:
 - 1. Use steel, plywood or lined board forms.
 - 2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
 - 3. Install form lining with close-fitting square joints between separate sheets without springing into place.
 - 4. Use full size sheets of form lines and plywood wherever possible.
 - 5. Tape joints to prevent protrusions in concrete.
 - 6. Use care in forming and stripping wood forms to protect corners and edges.
 - 7. Level and continue horizontal joints.
 - 8. Keep wood forms wet until stripped.
- D. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 301 ACI 318.

- E. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- F. Obtain Architect/Engineer's approval before framing openings in structural members not indicated on Drawings.
- G. Install fillet and chamfer strips on external corners of beams joists columns and.
- H. Install void forms in accordance with manufacturer's recommendations.
 - 1. SureVoid Products, Inc., Englewood, CO (800) 458-5444.
- I. Do not reuse wood formwork more than times for concrete surfaces to be exposed to view. Do not patch formwork.

3.3 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces are indicated to receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
- D. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse. For exposed work, do not reuse forms with damaged faces or edges. Apply form coating to forms in accordance with manufacturer's specifications. Do not coat forms for concrete indicated to receive "scored finish". Apply form coatings before placing reinforcing steel.

3.4 INSTALLATION - INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Install formed openings for items to be embedded in or passing through concrete work.
- B. Locate and set in place items required to be cast directly into concrete.
- C. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.
- D. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- G. Form Ties:
 - 1. Use sufficient strength and sufficient quantity to prevent spreading of forms.
 - 2. Place ties at least 1 inch away from finished surface of concrete.

3. Leave inner rods in concrete when forms are stripped.
 4. Space form ties equidistant, symmetrical and aligned vertically and horizontally unless otherwise shown on Drawings.
- H. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.
- I. Construction Joints:
1. Install surfaced pouring strip where construction joints intersect exposed surfaces to provide straight line at joints.
 2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
 3. Show no overlapping of construction joints. Construct joints to present same appearance as butted plywood joints.
 4. Arrange joints in continuous line straight, true and sharp.
- J. Openings for Items Passing Through Concrete:
1. Frame openings in concrete where indicated on Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections.
 2. Coordinate work to avoid cutting and patching of concrete after placement.
 3. Perform cutting and repairing of concrete required as result of failure to provide required openings.
- K. Screeds:
1. Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs.
 2. Slope slabs to drain where required or as shown on Drawings.
 3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms. Remove freestanding water.
- L. Screenshot Supports:
1. For concrete over waterproof membranes and vapor retarder membranes, use cradle, pad or base type screenshot supports which will not puncture membrane.
 2. Staking through membrane is not be permitted.
- M. Cleanouts and Access Panels:
1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris and waste material.
 2. Clean forms and surfaces against which concrete is to be placed. Remove chips, saw dust and other debris. Thoroughly blow out forms with compressed air just before concrete is placed.

3.5 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.6 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and removal has been approved by Architect/Engineer.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.
- D. Leave forms in place for minimum number of days as specified in ACI 347.

3.7 ERECTION TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 301 ACI 318.

***** OR *****

- B. Camber slabs and beams 1/4 inch per 10 feet in accordance with ACI 301 ACI 318.

3.8 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements 017000 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- C. Notify Architect/Engineer after placement of reinforcing steel in forms, but prior to placing concrete.
- D. Schedule concrete placement to permit formwork inspection before placing concrete.

END OF SECTION 031000

SECTION 03 15 00 – CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes wheel stops.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of exposed finish requiring color selection.
- C. Samples for Verification: For wheel stops, 6 inches (150 mm) long showing color and cross section; with fasteners.

PART 2 - PRODUCTS

2.1 PARKING BUMPERS

- A. Concrete Wheel Stops: Precast, steel-reinforced, air-entrained concrete, 4000-psi (27.6-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, transverse drainage slots on underside, and a minimum of two factory-formed or -drilled vertical holes through wheel stop for anchoring to substrate.
 - 1. Surface Appearance: Free of pockets, sand streaks, honeycombs, and other obvious defects. Corners shall be uniform, straight, and sharp.
 - 2. Mounting Hardware: Galvanized-steel hardware as standard with wheel-stop manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WHEEL STOP INSTALLATION

- A. General: Install wheel stops according to manufacturer's written instructions unless otherwise indicated.
- B. Install wheel stops in bed of adhesive before anchoring.

- C. Securely anchor wheel stops to pavement with hardware in each preformed vertical hole in wheel stop as recommended in writing by manufacturer. Recess head of hardware beneath top of wheel stop.

END OF SECTION 03 15 00

SECTION 032000 CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Reinforcing bars.
 - 2. Welded wire fabric.
 - 3. Reinforcement accessories.
- B. Related Sections:
 - 1. Section 031000 - Concrete Forms and Accessories.
 - 2. Section 033000 - Cast-in-Place Concrete.
 - 3. Section 033500 - Concrete: Reinforcement for concrete floor toppings.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 318 - Building Code Requirements for Structural Concrete.
 - 3. ACI 530.1 - Specifications for Masonry Structures.
 - 4. ACI SP-66 - ACI Detailing Manual.
- B. ASTM International:
 - 1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 2. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - 3. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - 4. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 - 5. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 6. ASTM A704/A704M - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
 - 7. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 8. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - 9. ASTM A775/A775M - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
 - 10. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
 - 11. ASTM A934/A934M - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
 - 12. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
 - 13. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars.

- C. American Welding Society:
 - 1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
- D. Concrete Reinforcing Steel Institute:
 - 1. CRSI - Manual of Standard Practice.
 - 2. CRSI - Placing Reinforcing Bars.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate bar sizes, spacings, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules, and supporting and spacing devices.
- C. Certificates: Submit AWS qualification certificate for welders employed on the Work.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
 - 1. Submit certified copies of mill test report of reinforcement materials analysis.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with CRSI - Manual of Standard Practice, ACI 301, and ACI 318.
- B. Prepare shop drawings in accordance with ACI SP-66.

1.5 QUALIFICATIONS

- A. Welders: AWS qualified within previous 12 months.

1.6 COORDINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate with placement of formwork, formed openings and other Work.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. Deformed and Plain Reinforcement: ASTM A615/A615M; 60 ksi yield strength, steel bars, unfinished.

2.2 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16 gage annealed.
- B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions including load bearing pad on bottom to prevent vapor retarder puncture.

- C. Special Chairs, Bolsters, Bar Supports, Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic tipped steel; size and shape to meet Project conditions.
- D. Reinforcing Splicing Devices: Mechanical type; full tension and compression; sized to fit joined reinforcing.
- E. Epoxy Coating Patching Material: Type as recommended by coating manufacturer.

2.3 FABRICATION

- A. Fabricate concrete reinforcement in accordance with CRSI Manual of Practice, and ACI 318, on and all applicable codes.
- B. Form standard hooks for 180 degree bends, 90 degree bend, stirrup and tie hooks, and seismic hooks as indicated on Drawings.
- C. Form reinforcement bends with minimum diameters in accordance with ACI 318 and all applicable codes.
- D. Fabricate column reinforcement with offset bends at reinforcement splices.
- E. Form spiral column reinforcement from minimum 3/8 inch diameter continuous deformed bar or wire.
- F. Form ties and stirrups from the following:
 - 1. For bars No. 10 and Smaller: No. 3 deformed bars.
 - 2. For bars No. 11 and Larger: No. 4 deformed bars.
- G. Weld reinforcement in accordance with AWS D1.4.
- H. Galvanized Epoxy-Coated Reinforcement: Clean surfaces, weld and re-protect welded joint in accordance with CRSI.
- I. Locate reinforcement splices not indicated on Drawings, at point of minimum stress. Review location of splices with Architect/Engineer.

2.4 SOURCE QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Make completed reinforcement available for inspection at manufacturer's factory prior to packaging for shipment. Notify Architect/Engineer at least seven days before inspection is allowed.
- C. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
 - 1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position beyond specified tolerance.
 - 1. Do not weld crossing reinforcement bars for assembly.
- B. Do not displace or damage vapor retarder.
- C. Accommodate placement of formed openings.
- D. Space reinforcement bars with minimum clear spacing in accordance with ACI 318 of one bar diameter, but not less than 1 inch.
 - 1. Where bars are indicated in multiple layers, place upper bars directly above lower bars.
- E. Maintain concrete cover around reinforcement in accordance with ACI 318 applicable code as follows:

| | | |
|--|-------------------------|--------------|
| Footings and Concrete Formed Against Earth | | 3 inches |
| Concrete exposed to earth or weather | No. 6 bars and larger | 2 inches |
| | No. 5 bars and smaller | 1-1/2 inches |
| Supported Slabs, Walls, and Joists | No. 14 bars and larger | 1-1/2 inches |
| | No. 11 bars and smaller | 3/4 inches |
| Beams and Columns | | 1-1/2 inches |
| Shell and Folded Plate Members | No. 6 bars and larger | 3/4 inches |
| | No. 5 bars and smaller | 1/2 inches |

3.2 ERECTION TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Install reinforcement within the following tolerances for flexural members, walls, and compression members:

| Reinforcement Depth | Depth Tolerance | Concrete Cover Tolerance |
|-----------------------|------------------------|--------------------------|
| Greater than 8 inches | plus or minus 3/8 inch | minus 3/8 inch |
| Less than 8 inches | plus or minus 1/2 inch | minus 1/2 inch |

- C. Install reinforcement within the tolerances specified in ACI 530.1 for foundation walls.

3.3 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Field inspection and testing will be performed by Owner's testing laboratory in accordance with ACI 318 and IBC 2006.
- C. Provide free access to Work and cooperate with appointed firm.
- D. Reinforcement Inspection:
 - 1. Placement Acceptance: Specified and ACI 318 material requirements and specified placement tolerances.
 - 2. Welding: Inspect welds in accordance with AWS D1.1.
 - 3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.
 - 4. Weldability Inspection: Inspect for reinforcement weldability when formed from steel other than ASTM A706/A706M.
 - 5. Continuous Weld Inspection: Inspect reinforcement as required by ACI 318.
 - 6. Periodic Weld Inspection: Other welded connections.

3.4 SCHEDULES

- A. Reinforcement For Superstructure Framing Members: Deformed bars, unfinished.
- B. Reinforcement For Foundation Wall Framing Members and Slab-on-Grade: Deformed bars and wire fabric, galvanized finish.
- C. Reinforcement For Parking Structure Framing Members: Deformed bars, epoxy-coated finish.

END OF SECTION 032000

SECTION 033000 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete for the following:
 - 1. Foundation walls.
 - 2. Supported slabs.
 - 3. Slabs on grade.
 - 4. Control, expansion and contraction joint devices.
 - 5. Equipment pads.
 - 6. Light pole base.
 - 7. Flagpole base.
- B. Related Sections:
 - 1. Section 031000 - Concrete Forms and Accessories: Formwork and accessories. Placement of joint device joint device anchors in formwork.
 - 2. Section 032000 - Concrete Reinforcement.
 - 3. Section 033500 - Concrete Finishing.
 - 4. Section 033900 - Concrete Curing.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 305 - Hot Weather Concreting.
 - 3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
 - 4. ACI 308.1 - Standard Specification for Curing Concrete.
 - 5. ACI 318 - Building Code Requirements for Structural Concrete.
- B. ASTM International:
 - 1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 2. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 3. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 5. ASTM C42/C42M - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 6. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
 - 7. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 8. ASTM C150 - Standard Specification for Portland Cement.
 - 9. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - 10. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
14. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
15. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
16. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
17. ASTM C685/C685M - Standard Specification for Concrete Made By Volumetric Batching and Continuous Mixing.
18. ASTM C845 - Standard Specification for Expansive Hydraulic Cement.
19. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
20. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
21. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
22. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
23. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
24. ASTM C1157 - Standard Performance Specification for Hydraulic Cement.
25. ASTM C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
26. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures.
27. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
28. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
29. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
30. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
31. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
32. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
33. ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
34. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.3 PERFORMANCE REQUIREMENTS

- A. Vapor Retarder Permeance: Maximum .03 perm when tested in accordance with ASTM E96.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on joint devices, attachment accessories, admixtures.
- C. Design Data:
 - 1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
 - a. Hot and cold weather concrete work.
 - b. Air entrained concrete work.
 - 2. Identify mix ingredients and proportions, including admixtures.
 - 3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.
- D. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent Work.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Accurately record actual locations of embedded utilities and components concealed from view in finished construction.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 and ACI 318.
- B. Conform to ACI 305 when concreting during hot weather.
- C. Conform to ACI 306.1 when concreting during cold weather.
- D. Acquire cement and aggregate from one source for Work.

1.7 COORDINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Maintain concrete temperature after installation at minimum 50 degrees F for minimum 7 days.

1.9 COORDINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I - Normal
- B. Normal Weight Aggregates: ASTM C33.
 - 1. Coarse Aggregate Maximum Size: 1.5
- C. Water: ACI 318; potable, without deleterious amounts of chloride ions.

2.2 ADMIXTURES

- A. Air Entrainment: ASTM C260.
- B. Fly Ash: ASTM C618 type C or F.
- C. Silica Fume: ASTM C1240.

2.3 ACCESSORIES

- A. Vapor Retarder: ASTM E1745 Class A; 10 mil thick; type recommended for below grade application. Furnish joint tape recommended by manufacturer.
- B. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.

2.4 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler; Asphalt impregnated fiberboard or felt, tongue and groove profile.

***** OR *****

- B. Joint Filler: ASTM D1752; Closed cell, resiliency of 95 percent if not compressed more than 50 percent of original thickness.
- C. Sealant: ASTM C309, Type I approved by Asphalt and Vinyl composition Tile Institute, 30% minimum solids content.

2.5 CONCRETE MIX

- A. Select proportions for normal weight concrete in accordance with ACI 301 Method 1
- B. Provide concrete for the following criteria:

| Material and Property | Measurement |
|-------------------------------|--|
| Compressive Strength (7 day) | 2100 psi |
| Compressive Strength (28 day) | 3000 psi |
| Cement Type | ASTM C150 |
| Aggregate Size (maximum) | 1.5 inch |
| Air Content | Do not use air entrainment for concrete mixes. |
| Slump | 5 inches |

- C. Admixtures: Include admixture types and quantities indicated in concrete mix designs only when approved by Architect/Engineer.
 - 1. Use accelerating admixtures in cold weather. Use of admixtures will not relax cold weather placement requirements.
 - 2. Do not use calcium chloride nor admixtures containing calcium chloride.
 - 3. Use set retarding admixtures during hot weather.
- D. Site Mixed Concrete: No site mixed concrete is allowed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Remove laitance, coatings, and unsound materials.
- B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.

3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301.
- B. Notify testing laboratory and Architect/Engineer minimum 24 hours prior to commencement of operations.
- C. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and are not disturbed during concrete placement.
- D. Install vapor retarder under interior slabs on grade in accordance with ASTM E1643. Lap joints minimum 6 inches and seal watertight by adhesive applied between overlapping edges and ends as per manufacturer recommendations.
- E. Repair vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.
- F. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- G. Install joint device anchors. Maintain correct position to allow joint cover to be flush with floor finish.
- H. Install joint covers in one piece longest practical length, when adjacent construction activity is complete.
- I. Deposit concrete at final position. Prevent segregation of mix.
- J. Place concrete in continuous operation for each panel or section determined by predetermined joints.
- K. Consolidate concrete.
- L. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- M. Place concrete continuously between predetermined expansion, control, and construction joints.

- N. Do not interrupt successive placement; do not permit cold joints to occur.
- O. Saw cut joints within 12 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.
- P. Screed floors and slabs on grade level, maintaining surface flatness of F_r of 35.

3.4 CONCRETE FINISHING

- A. Finish concrete floor surfaces to requirements of Section 03350.
- B. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains.

3.5 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
 - 1. Protect concrete footings from freezing for minimum 5 days.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Cure floor surfaces as specified in Section 03390.
- D. Ponding: Maintain 100 percent coverage of water over floor slab areas continuously for 7 days.
- E. Spraying: Spray water over floor slab areas and maintain wet for 7 days.

3.6 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Field inspection and testing will be performed by Owner's testing laboratory in accordance with ACI 318
- C. Provide free access to Work and cooperate with appointed firm.
- D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.
- E. Concrete Inspections:
 - 1. Continuous Placement Inspection: Inspect for proper installation procedures.
 - 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
- F. Strength Test Samples:
 - 1. Sampling Procedures: ASTM C172.

2. Cylinder Molding and Curing Procedures: ASTM C31/C31M, cylinder specimens, standard cured field cured.
 3. Sample concrete and make one set of three cylinders for every 150 cu yds or less of each class of concrete placed each day and for every 5,000 sf of surface area for slabs and walls.
 4. When volume of concrete for any class of concrete would provide less than 3 sets of cylinders, take samples from three randomly selected batches, or from every batch when less than 3 batches are used.
 5. Make one additional cylinder during cold weather concreting, and field cure.
- G. Field Testing:
1. Slump Test Method: ASTM C143/C143M.
 2. Air Content Test Method: ASTM C173/C173M.
 3. Temperature Test Method: ASTM C1064/C1064M.
 4. Measure slump and temperature for each compressive strength concrete sample.
 5. Measure air content in air entrained concrete for each compressive strength concrete sample.
- H. Cylinder Compressive Strength Testing:
1. Test Method: ASTM C39.
 2. Test Acceptance: In accordance with ACI 318 .
 3. Test one cylinder at 7 days.
 4. Test two cylinders at 28 days.
 5. Dispose remaining cylinders when testing is not required.
- I. Core Compressive Strength Testing:
1. Sampling and Testing Procedures: ASTM C42/C42M.
 2. Test Acceptance: In accordance with ACI 318.
 3. Drill three cores for each failed strength test from concrete represented by failed strength test.
- J. Water Soluble Chloride Ion Concentration Test Method: ASTM C1218; tested at 28 days.
1. Maximum Concentration: As permitted by applicable code.
- K. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

3.7 PATCHING

- A. Allow Architect/Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Architect/Engineer upon discovery.
- C. Patch imperfections as directed by Architect/Engineer

3.8 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by Architect/Engineer.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect/Engineer for each individual area.

3.9 SCHEDULE - CONCRETE TYPES AND FINISHES

- A. Foundation Walls: 3,000 psi 28 day concrete, form finish with honeycomb filled surface.
- B. Underside of Supported Floors and Structure Exposed to View: 4,000 psi 28 day concrete, sack rubbed finish.
- C. Exposed Portico Structure: 4,000 psi 28 day concrete, air entrained, smooth stone rubbed finish.

3.10 SCHEDULE - JOINT FILLERS

- A. Basement Floor Slab Perimeter: Joint filler Type A set 1/8 inch below floor slab elevation.
- B. Exterior Retaining Wall at Loading Dock: Joint filler Type F recessed 3/8 inch with sealant cover.

END OF SECTION 033000

SECTION 03 35 00 – CONCRETE FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Single application sealer-hardener for concrete floors.
 - 2. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, application instructions, and recommendations. Include data substantiating product complies with requirements of the contract documents.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements for the IBC for interior finishes.
 - 2. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
- B. Manufacturer Qualifications: Provide products produced by a company specializing in production of concrete sealers for minimum of 5 years.

1.5 PROJECT CONDITIONS

- A. Environmental Requirements: Do not proceed with installation until areas to receive work are enclosed and temperature and relative humidity are stabilized and maintained for optimum quality control.
- B. Environmental Limitations: Comply with coating manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and conditions affecting floor treatment application. Do not apply coating until wet work in spaces is complete and dry; and overhead work, including installing mechanical systems, lighting, and athletic equipment, is complete.
 - 1. Apply floor coatings when substrate temperature and surrounding air temperatures are between 50 degrees F and 95 degrees F (10 degrees F and 35 degrees C).
 - 2. Do not apply floor coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F (3 degrees C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Specifications: Ashford Formula as manufactured by Curecrete Chemical Company. Subject to compliance with requirements, provide basis of design produce or comparable by one of the following:
 - 1. Evercrete Company.
 - 2. PROSOCO, Inc.
 - 3. WR Meadows.
- B. Cure-Seal-Hardener: Water-based, chemically reactive penetrating sealer and hardener that densifies concrete to seal against water molecules, but allows air and water vapor to pass, so that concrete can achieve full compressive strength for minimized surface crazing and elimination of dusting.
 - 1. Abrasion Resistance to Revolving Disks: At least a 32.5% improvement over untreated samples when tested in accordance with ASTM C779.
 - 2. Surface Adhesion: At least a 22% increase in adhesion for epoxy when tested in accordance with ASTM D3359.
 - 3. Hardening: As follows when tested in accordance with ASTM C39:
 - a. After 7 Days: An increase of at least 40% over untreated samples.
 - b. After 28 Days: An increase of at least 38% over untreated samples.
 - 4. Coefficient of Friction: 0.86 dry, 0.69 wet when tested in accordance with ASTM C1028.
 - 5. Rebound Number: An increase of at least 13.3% over untreated samples when tested in accordance with ASTM C805.
 - 6. Light Exposure Degradation: No evidence of adverse effects on treated samples when tested in accordance with ASTM G23.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for conditions affecting performance and conditions of floor treatment.
 - 1. Verify compatibility with and suitability of substrates, including existing finishes or primers.
 - 2. Verify plasticizers in existing concrete substrate will not impair bond.
 - 3. Proceed with installation after correcting unsatisfactory conditions

3.2 PREPARATION

- A. Clean substrate, removing chalk lines, pencil lines and other layout lines as well as projections and substances detrimental to the work; comply with recommendations of manufacturer of products to be installed for proper preparation procedures. Mask off or protect adjacent surfaces not scheduled to receive sealer.

3.3 APPLICATION

- A. Spray apply sealer to comply with manufacturer's instructions except where project conditions require extra precautions or provisions to ensure satisfactory performance of the work.
 - 1. Apply sealer to produce surface without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or surface imperfections. Produce sharp glass lines and color breaks.

3.1 CLEANING

- A. After completing application, clean spattered surfaces. Remove spattered sealer by washing or other appropriate methods for coating. Do not scratch or damage adjacent finished surfaces.
- B. Clean Up: Remove rubbish, empty cans, rags, and discarded materials from site daily. Rinse and recycle or legally dispose of sealer and coating containers.

3.2 PROTECTION

- A. Institute protective procedures and install protective materials as required to ensure that work of this section will be without damage or deterioration at substantial completion.

END OF SECTION 03 35 00

SECTION 033500 CONCRETE FINISHING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Finishing concrete floors [and floor toppings].
 - 2. Floor surface treatment.
- B. Related Sections:
 - 1. Section 033000 - Cast-in-Place Concrete: [Prepared concrete floors ready to receive finish;] [control and formed expansion and contraction joints and joint devices].
 - 2. Section 03360 - Concrete Finishes: Exposed aggregate finish.
 - 3. Section 033900 - Concrete Curing.
 - 4. Section 079513 - Expansion Joint Cover Assemblies.
 - 5. Section 079200 - Joint Sealers.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 302.1 - Guide for Concrete Floor and Slab Construction.
- B. ASTM International:
 - 1. ASTM E1155 - Standard Test Method for Determining Floor Flatness and of Levelness Using the F-number System.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on concrete hardener, sealer, curing compounds curing papers and slip resistant treatment, compatibilities, and limitations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit data on maintenance renewal of applied coatings.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 and ACI 302.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.

- B. Deliver materials in manufacturer's packaging including application instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.

1.8 COMPOUNDS - HARDENERS AND SEALERS

- A. Chemical Hardener: Magnesium fluorosilicate and zinc fluorosilicate blend

PART 2 EXECUTION

2.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify floor surfaces are acceptable to receive the Work of this section.

2.2 FLOOR FINISHING

- A. Finish concrete floor surfaces in accordance with ACI 301 and ACI 302.1.
- B. Wood float surfaces receiving quarry tile, ceramic tile, and cementitious terrazzo with full bed setting system.
- C. Steel trowel surfaces receiving carpeting, resilient flooring, seamless flooring, thin set terrazzo, thin set quarry tile, and thin set ceramic tile.
- D. Steel trowel surfaces which are scheduled to be exposed.

2.3 TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Measure for F(F) and F(L) tolerances for floors in accordance with ASTM E1155, within 48 hours after slab installation.
- C. Finish concrete to achieve the following tolerances:
 - 1. Under Glazed Tile on Setting Bed: F(F) 35 and F(L) 20.
 - 2. Under Resilient Finishes: F(F) 75 and F(L) 50.
 - 3. Exposed to View and Foot Traffic: F(F) 75 and F(L) 40.
 - 4. Correct slab surface when actual F(F) or F(L) number for floor installation measures less than required.
- D. Correct defects in defined traffic floor by grinding or removal and replacement of defective Work. Areas requiring corrective Work will be identified. Re-measure corrected areas by same process.

END OF SECTION 033500

CONCRETE FINISHING
033500-2

SECTION 03 36 00 – CONCRETE FINISHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Resurfacing of interior concrete floors.
 - 2. Elimination of water bearing cracks.
 - 3. Moisture reduction barrier.

1.3 REFERENCES

- A. ANSI A118.4 – American National Standard Specifications for Modified Dry-Set Cement Mortar.
- B. ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
- C. ASTM D570 – Standard Test Methods for Water Absorption of Plastics.
- D. ASTM D229 – Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation.

1.4 SUBMITTALS

- A. Qualification Data: Submit copies of qualifications for refrigerant recovery technician.
- B. Product Data: Submit manufacturer's specifications, application instructions, and recommendations. Include data substantiating product complies with requirements of the contract documents.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements for the IBC for interior finishes.
 - 2. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
- B. Manufacturer Qualifications: Provide products produced by a company specializing in production of concrete sealers for minimum of 5 years

1.6 PROJECT CONDITIONS

- A. Environmental Requirements: Do not proceed with installation until areas to receive work are enclosed and temperature and relative humidity are stabilized and maintained for optimum quality control.
- B. Environmental Limitations: Comply with coating manufacturer's written instructions for substrate temperature, ambient temperature, humidity, ventilation, and conditions affecting floor treatment application. Do not apply coating until wet work in spaces is complete and dry; and overhead work, including installing mechanical systems, lighting, and athletic equipment, is complete.
 - 1. Apply floor coatings when substrate temperature and surrounding air temperatures are between 50 degrees F and 95 degrees F (10 degrees F and 35 degrees C).
 - 2. Do not apply floor coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 degrees F (3 degrees C) above the dew point; or to damp or wet surfaces.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Properly label and identify all containers as Sundeck materials.
- B. Deliver and store all materials to prevent damage to product and containers.
- C. Store all material in a clean, dry location where temperatures are maintained between 40 and 90 degrees Fahrenheit.
- D. Comply with manufacture's Material Safety Data Sheets (MSDS) for delivery, storage and handling of products.

1.8 COORDINATION

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Copolymer Modified Cementitious Spray Texture Finish: Classic Texture as manufactured by Sundeck Design Products, (817) 649-7292 or comparable product. Other acceptable product is Multicoat Krete Kote as manufactured by Multicoat Corporation, (877) 685-8426.

2.2 MATERIALS

- A. Sundeck Premix:
 - 1. Copolymer modified thin set cement coating to be used in conjunction with Sundeck Additive, available in Tan, Grey, Red and White colors.
- B. Sundeck Primer/Additive:
 - 1. Vinyl acetate emulsion with 53% solids content.
- C. Sundeck Finish Coat:
 - 1. Water base acrylic color effect available in 16 standard colors or any customer color choice as special order.
- D. Sundeck Clear Finish Coat:
 - 1. Water based acrylic clear coat with 20% solids.

- E No materials can be substituted other than those specified by Sundeck Products, Inc.

2.3 PERFORMANCE

| | | |
|---|--|-------------------------------|
| A | Weights lbs./ft @ (3/16")..... | 1.3 lbs. |
| B | Thickness (Typical)..... | 3/16". |
| C | Bond Strength (ASTM C297)..... | 469 psi. |
| D | Accelerated Aging (ASTM A756 D&E)..... | Unaffected. |
| E | Freeze-Thaw (ASTM C67)..... | No Breakage <1% weight loss. |
| F | Slip Resistance (S.C.O.F., ASTM C1028)..... | 81 Wet-1.03 dry. |
| G | Abrasion (ASTM D1242)..... | 0328 in. = 3000 psi Concrete. |
| H | Absorption (ASTM D570)..... | 12.7%. |
| I | Percolation (ASTM D1242) 48"/48hr..... | <1%. |
| J | Chemical Resistance (ASTM D229) 12 Reagents..... | Unaffected. |
| K | Impact Resistance (Mil D3134 F..... | No Breakage / < .62 in. |
| L | Concentrated Load Test (500 lb)..... | No Breakage / < .001 in. |

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that affected utilities have been disconnected and capped before commencing selective demolition operations.
- B. Review Project Record Documents of existing construction or existing condition and hazardous material information provided by Owner. Owner does not warrant existing conditions are same as those indicated in Project Record Documents.
- C. Perform an engineering survey of condition of building to determine whether removing an element might result in structural deficiency or unplanned collapse of a portion of structure or adjacent structures during selective building demolition operations.
 1. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions with measured drawings or preconstruction photographs or video and templates.
 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities. Comply with requirements for access and protection.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Protect ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 3. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 4. Comply with requirements for temporary enclosures, dust control, heating, and cooling.
- C. Furnishings and Equipment: Cover and protect furniture, equipment, and fixtures from spoilage or damage as necessary.
- D. Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
 - 1. Construct dustproof partitions of not less than nominal 4 inch (100mm) studs, 5/8 inch (16mm) gypsum wallboard with joints taped on occupied side, and 1/2 inch (13mm) fire retardant plywood on the demolition side.
 - 2. Insulate partition to provide noise protection to occupied areas.
 - 3. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
 - 4. Protect air handling equipment.
 - 5. Weatherstrip openings to prevent the spread of dust.

3.3 POLLUTION CONTROLS

- A. Dust Control: Use water mist, temporary enclosures, and suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.
 - 1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
 - 2. Wet mop floors to eliminate trackable dirt and wipe down doors of demolition enclosure. Vacuum carpeted areas.

3.4 SELECTIVE DEMOLITION

- A. Demolish and remove existing construction to the extent necessary for new work. Use methods required to complete the work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations before disturbing supporting members on the next lower level.
 - 2. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame cutting operations. Maintain portable fire suppression devices during flame cutting operations.
 - 3. Maintain adequate ventilation when using cutting torches.
 - 4. Remove decayed, vermin infested, and dangerous or unsuitable materials and promptly dispose of offsite.
 - 5. Dispose of demolished items and materials promptly.

- B. Site Access and Temporary Controls: Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and adjacent occupied and used facilities.
- C. Removed and Salvaged Items: Remove items indicated for salvage. Clean and pack or crate items after cleaning. Identify contents of containers. Store items in secure area until delivery to Owner.
 - 1. Transport items to Owner's storage area designated by Owner. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items: Clean and repair items to functional condition adequate for intended reuse.
 - 1. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 2. Protect items from damage during transport and storage.
 - 3. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner, items may be removed to a suitable, protected storage location during selective demolition, cleaned, and reinstalled in original locations after selective demolition operations are complete.
- F. Patching and Repair: Repair damage to adjacent construction caused by selective demolition operations promptly.

3.5 PATCHING AND REPAIRS

- A. Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Patching: Comply with Section 01 73 29.
- C. Repairs: When necessary to repair to existing surfaces, patch to produce surfaces suitable for new materials.
- D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
- E. Floors: Patch and repair floor surfaces in the new space. Provide an even surface of uniform finish color, texture, and appearance. Remove existing floor and replace with new materials, if necessary, to achieve uniform color and appearance.
 - 1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
 - 2. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
 - 3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Legally remove demolition waste materials from site and dispose in an EPA approved construction and demolition waste landfill acceptable to authorities having jurisdiction recycle or reuse components.
 - 1. Do not allow demolished materials to accumulate on site.

2. Remove and transport debris to prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or devices that conveys debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 03 36 00

SECTION 033900 CONCRETE CURING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes initial and final curing of horizontal and vertical concrete surfaces.
- B. Related Sections:
 - 1. Section 033000 - Cast-In-Place Concrete.
 - 2. Section 033500 - Concrete Finishing.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 302.1 - Guide for Concrete Floor and Slab Construction.
 - 3. ACI 308.1 - Standard Specification for Curing Concrete.
 - 4. ACI 318 - Building Code Requirements for Structural Concrete.
- B. ASTM International:
 - 1. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
 - 2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 3. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - 4. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on curing compounds, mats, paper, film, compatibilities, and limitations.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Membrane Curing Compound Type 1.
- B. Membrane Curing Compound: ASTM C1315 Type I.
- C. Water: Potable, not detrimental to concrete.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify substrate surfaces are ready to be cured.

3.2 INSTALLATION - HORIZONTAL SURFACES

- A. Cure concrete in accordance with ACI 308.1.
- B. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 4 days.

***** [OR] *****

- C. Spraying: Spray water over floor slab areas and maintain wet for 7 days.

***** [OR] *****

- D. Absorptive Mat: Spread cotton fabric over floor slab areas. Spray with water until mats are saturated, and maintain in saturated condition for 7 days.

***** [OR] *****

- E. Absorptive Mat: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place for 7 days.

3.3 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution Requirements: Protecting finished Work.
- B. Do not permit traffic over unprotected floor surface.

3.4 SCHEDULES

- A. Storage Area Slabs: Absorptive mats, burlap-polyethylene type.
- B. Retaining Walls: Membrane curing compound, acrylic type, clear color.
- C. Concrete Pavement: Membrane curing compound, opaque color.
- D. Other Floor Areas: Membrane curing compound, acrylic type, translucent color.

END OF SECTION 033900

SECTION 036000 GROUT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Portland cement grout.
 - 2. Rapid curing epoxy grout.
 - 3. Non-shrink cementitious grout.
- B. Related Sections:
 - 1. Section 033000 - Cast-in-Place Concrete.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 318 - Building Code Requirements for Structural Concrete.
- B. American Society of Testing and Materials:
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 2. ASTM C40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - 3. ASTM C150 - Standard Specification for Portland Cement.
 - 4. ASTM C191 - Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
 - 5. ASTM C307 - Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - 6. ASTM C531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - 7. ASTM C579 - Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, monolithic Surfacing and Polymer Concretes.
 - 8. ASTM C827 - Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
- C. U. S. Army Corps of Engineers Concrete Research Division (CRD):
 - 1. CRD C621 - Non-Shrink Grout.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT GROUT MATERIALS

- A. Portland Cement: ASTM C150, Type I and II.
- B. Water:
 - 1. Potable; containing no impurities, suspended particles, algae or dissolved natural salts in quantities capable of causing:
 - a. Corrosion of steel.
 - b. Volume change increasing shrinkage cracking.

- c. Efflorescence.
 - d. Excess air entraining.
- C. Fine Aggregate:
 - 1. Washed natural sand.
 - 2. Gradation in accordance with ASTM C33 and represented by smooth granulometric curve within required limits.
 - 3. Free from injurious amounts of organic impurities as determined by ASTM C40.
- D. Mix:
 - 1. Portland cement, sand and water. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID CURING EPOXY GROUT

- A. Rapid Curing Epoxy Grout: High strength, three component epoxy grout formulated with thermosetting resins and inert fillers. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids and alkalis.

| | | |
|--------------------------|-----------|-------------------------|
| Compressive Strength | ASTM C579 | 12,000 psi at 7 days |
| Tensile Strength | ASTM C307 | 2,000 psi minimum |
| Coefficient of Expansion | ASTM C531 | 30x10-6 in per degree F |
| Shrinkage | ASTM C827 | None |

2.3 NON-SHRINK CEMENTITIOUS GROUT

- A. Properties: Certified to maintain initial placement volume or expand after set and meet the following minimum properties when tested in accordance with CRD-C621, for Type D non-shrink grout:

| Property | Test | Time | Result |
|----------------------|-----------|---------|--------------------------|
| Setting Time | ASTM C191 | Initial | 2 hours (Approx) |
| | | Final | 3 hours (Approx) |
| Expansion | | | 0.10% - 0.4% Maximum |
| Compressive Strength | CRD-C621 | 1 day | 4,000 psi |
| | | 7 days | 7,000 psi |
| | | 28 days | 10,000 psi to 10,800 psi |

2.4 FORMWORK

- A. Refer to Section 031000 for formwork requirements.

2.5 CURING

- A. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or with use of wet burlap method.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until sound, clean concrete surface is achieved.
- B. Rough concrete lightly, but not enough to interfere with placement of grout.
- C. Remove foreign materials from metal surfaces in contact with grout.
- D. Align, level and maintain final positioning of components to be grouted.
- E. Saturate concrete surfaces with clean water; remove excess water, leave none standing.

3.2 MIXING

- A. Portland Cement Grout:
 - 1. Use proportions of 2 parts sand and 1 part cement, measured by volume.
 - 2. Prepare grout with water to obtain consistency to permit placing and packing.
 - 3. Mix water and grout in two steps; pre-mix using approximately 2/3 of water; after partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing 2 to 3 minutes.
 - 4. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
 - 5. Do not add additional water after grout has been mixed.
 - 6. Capable of developing minimum compressive strength of 2400 psi in 48 hours and 7000 psi in 28 days.

***** [OR] *****

3.3 PLACING GROUT

- A. Place grout material quickly and continuously.
- B. Do not use pneumatic-pressure or dry-packing methods.
- C. Apply grout from one side only to avoid entrapping air.
- D. Do not vibrate placed grout mixture, or permit placement when area is being vibrated by nearby equipment.
- E. Thoroughly compact final installation and eliminate air pockets.
- F. Do not remove leveling shims for at least 48 hours after grout has been placed.

3.4 CURING

- A. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.

- B. After grout has attained its initial set, keep damp for minimum of 3 days.

3.5 FIELD QUALITY CONTROL

- A. Submit proposed mix design of each class of grout to inspection and testing firm for review prior to commencement of Work.
- B. Tests of grout components may be performed to ensure conformance with specified requirements.

END OF SECTION 036000

SECTION 040514 MASONRY MORTAR AND GROUT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes mortar and grout for masonry.
- B. Related Sections:
 - 1. Section 042000 - Unit Masonry Assemblies: Installation of mortar and grout.
 - 2. Section 042016 - Reinforced Unit Masonry Assemblies: Installation of mortar and grout.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 530 - Building Code Requirements for Masonry Structures.
 - 2. ACI 530.1 - Specifications for Masonry Structures.
- B. ASTM International:
 - 1. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
 - 2. ASTM C91 - Standard Specification for Masonry Cement.
 - 3. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
 - 4. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 5. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
 - 6. ASTM C150 - Standard Specification for Portland Cement.
 - 7. ASTM C199 - Standard Test Method for Pier Test for Refractory Mortars.
 - 8. ASTM C206 - Standard Specification for Finishing Hydrated Lime.
 - 9. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
 - 10. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - 11. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
 - 12. ASTM C476 - Standard Specification for Grout for Masonry.
 - 13. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
 - 14. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
 - 15. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
 - 16. ASTM C1142 - Standard Specification for Extended Life Mortar for Unit Masonry.
 - 17. ASTM C1314 - Standard Test Method for Constructing and Testing Masonry Prisms Used to Determine Compliance with Specified Compressive Strength of Masonry.
 - 18. ASTM C1329 - Standard Specification for Mortar Cement.
 - 19. ASTM C1357 - Standard Test Method for Evaluating Masonry Bond Strength.

1.3 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal requirements.
- B. Design Data: Submit design mix when Property specification of ASTM C270 is to be used, required environmental conditions, and admixture limitations.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 530 and ACI 530.1.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Cold Weather Requirements: In accordance with ACI 530.1 when ambient temperature or temperature of masonry units is less than 40 degrees F.
- C. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than 8 mph.

PART 2 PRODUCTS

2.1 COMPONENTS

- A. Portland Cement: ASTM C150, Type I
- B. Calcium chloride is not permitted.

2.2 MIXES

- A. Mortar Mixes:
 - 1. Extended Life Mortar: ASTM C1142, Type RS
- B. Mortar Mixing:
 - 1. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
 - 2. Achieve uniformly damp sand immediately before mixing process.
 - 3. Re-temper only within two hours of mixing.
- C. Grout Mixes:
 - 1. Grout for Non-Structural Masonry: 3,000 psi strength at 28 days; 8-11 inches slump; mixed in accordance with ASTM C476 grout.
 - 2. Grout for Structural Masonry: 3,000 psi strength at 28 days; 8-11 inches slump; mixed in accordance with ASTM C476 grout.
 - 3. Application:
 - a. Coarse Grout: For grouting spaces with minimum 4 inches dimension in every direction.
 - b. Fine Grout: For grouting other spaces.
- D. Grout Mixing:
 - 1. Mix grout in accordance with ASTM C94/C94M, modified to use ingredients complying with ASTM C476.
 - 2. Add admixtures; mix uniformly.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Request inspection of spaces to be grouted.

3.2 INSTALLATION

- A. Install mortar and grout in accordance with ACI 530.1 Specifications for Masonry Structures.

3.3 FIELD QUALITY CONTROL

- A. Establishing Mortar Mix: In accordance with ASTM C270.
- B. Testing Frequency: One set of specified tests for every 5,000 sf of completed wall area.
- C. Testing of Mortar Mix: In accordance with ASTM C780 for aggregate ratio and water content, air content, consistency, and compressive strength.
- D. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength, and in accordance with ASTM C143/C143M for slump.
- E. Test compressive strength of mortar and masonry to ASTM C1314; test in accordance with masonry unit sections specified.

END OF SECTION 040514

SECTION 042016 REINFORCED UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes concrete masonry units, reinforcement, anchorage, and accessories.
- B. Related Sections:
 - 1. Section 040514 - Masonry Mortar and Grout: Mortar and grout.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 530 - Building Code Requirements for Masonry Structures.
 - 2. ACI 530.1 - Specifications for Masonry Structures.
- B. ASTM International:
 - 1. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 2. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 3. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - 4. ASTM A580/A580M - Standard Specification for Stainless Steel Wire.
 - 5. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 7. ASTM A951 - Standard Specification for Masonry Joint Reinforcement.
 - 8. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
 - 9. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 10. ASTM C27 - Standard Classification of Fireclay and High-Alumina Refractory Brick.
 - 11. ASTM C34 - Standard Specification for Structural Clay Load-Bearing Wall Tile.
 - 12. ASTM C55 - Standard Specification for Concrete Brick.
 - 13. ASTM C56 - Standard Specification for Structural Clay Non-Load-Bearing Tile.
 - 14. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
 - 15. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
 - 16. ASTM C73 - Standard Specification for Calcium Silicate Face Brick (Sand-Lime Brick).
 - 17. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
 - 18. ASTM C126 - Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
 - 19. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units.

20. ASTM C140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units.
 21. ASTM C212 - Standard Specification for Structural Clay Facing Tile.
 22. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
 23. ASTM C315 - Standard Specification for Clay Flue Linings.
 24. ASTM C530 - Standard Specification for Structural Clay Non-Loadbearing Screen Tile.
 25. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 26. ASTM C652 - Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
 27. ASTM C744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
 28. ASTM C1261 - Standard Specification for Firebox Brick for Residential Fireplaces.
 29. ASTM C1283 - Standard Practice for Installing Clay Flue Lining.
 30. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 31. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
 32. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- C. National Fire Protection Association:
1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- D. Underwriters Laboratories Inc.:
1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 PERFORMANCE REQUIREMENTS

- A. Concrete Masonry Compressive Strength
1. Concrete Masonry Units: 1900 psi minimum net area compressive strength.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal requirements.
- B. Shop Drawings: Indicate bars sizes, spacings, locations, reinforcement quantities, bending and cutting schedules, supporting and spacing devices for reinforcement.
- C. Product Data:
1. Submit data for masonry units and fabricated wire reinforcement.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 530 and ACI 530.1.

1.6 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Cold Weather Requirements: In accordance with ACI 530.1 when ambient temperature or temperature of masonry units is less than 40 degrees F.
- C. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than 8 mph.

PART 2 PRODUCTS

2.1 COMPONENTS

- A. Hollow Load Bearing Concrete Masonry Units (CMU): ASTM C90; normal weight.

2.2 ACCESSORIES

- A. Single Wythe Joint Reinforcement: ASTM A951; ladder type; 0.148 inch diameter side rods with 0.148 inch diameter cross ties.
- B. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, deformed billet bars.
- C. Anchor Rods: ASTM A307; Grade C; J-shaped or L-shaped; complete with washers and heavy hex nuts; sized for minimum 15 inch embedment.
 - 1. Hot-Dipped Galvanizing: ASTM A153/A153M.
 - 2. Mechanical Galvanizing: ASTM B695; Class 55.
- D. Mortar and Grout: As specified in Section 04065.
- E. Joint Filler: Closed cell rubber; oversized 50 percent to joint width; self expanding.

2.3 SOURCE QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Test brick efflorescence in accordance with ASTM C67. Brick rated greater than "slightly effloresced" is not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.

- B. Verify field conditions are acceptable and are ready to receive work.
- C. Verify items provided by other sections of work are properly sized and located.
- D. Verify built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied to other Sections.
- B. Furnish temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent support.
- C. Wet clay and shale brick before laying when initial rate of absorption is greater than 30 grams when tested in accordance with ASTM C67.

3.3 INSTALLATION

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.
- C. Coursing of Concrete Masonry Units:
 - 1. Bond: Running.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches.
 - 3. Mortar Joints: Concave.
- D. Placing And Bonding:
 - 1. Lay solid masonry units in full bed of mortar, with full head joints.
 - 2. Lay hollow masonry units with face shell bedding on head and bed joints.
 - 3. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
 - 4. Remove excess mortar as Work progresses.
 - 5. Interlock intersections and external corners.
 - 6. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment is required, remove mortar and replace.
 - 7. Perform job site cutting of masonry units with proper tools to assure straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
 - 8. Isolate masonry from vertical structural framing members with movement joint .
 - 9. Isolate top of masonry from horizontal structural framing members and slabs or decks.
- E. Joint Reinforcement And Anchorage:
 - 1. Install horizontal joint reinforcement 16 inches oc.
 - 2. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
 - 3. Place joint reinforcement continuous in first and second joint below top of walls.
 - 4. Lap joint reinforcement ends minimum 6 inches.
 - 5. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
 - 6. Embed anchors embedded in concrete attached to structural steel members. Embed anchorages in every sixth brick.

- F. Lintels:
1. Install precast concrete lintels over openings.
 2. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled or indicated.
 3. Openings Up To 42 inches Wide: Reinforce openings as indicated on Drawings.
 4. Openings From 42 inches Up To 78 inches Wide: Reinforce openings as indicated on Drawings.
 5. Openings Over 78 inches: Reinforce openings as indicated on Drawings.
 6. Do not splice reinforcing bars.
 7. Support and secure reinforcing bars from displacement.
 8. Place and consolidate grout fill without displacing reinforcing.
 9. Allow masonry lintels to attain specified strength before removing temporary supports.
 10. Maintain minimum 8 inches bearing on each side of opening.
- G. Grouted Components:
1. Reinforce bond beam with 1, No. 5 bar.
 2. Reinforce pilaster with 1, No. 6 bar in each cell.
 3. Lap splices bar diameters required by code.
 4. Support and secure reinforcing bars from displacement.
 5. Place and consolidate grout fill without displacing reinforcing.
 6. At bearing locations, fill masonry cores with grout for minimum 12 inches either side of opening.
- H. Reinforced Masonry:
1. Lay masonry units with cells vertically aligned and cavities between wythes clear of mortar and unobstructed.
 2. Place reinforcing, reinforcement bars, and grout as indicated on Drawings.
 3. Splice reinforcement in accordance with Section 03200.
 4. Support and secure reinforcement from displacement.
 5. Place and consolidate grout fill without displacing reinforcing.
 6. Place grout in accordance with ACI 530.1 Specification for Masonry Structures.
- I. Control And Expansion Joints:
1. Install control and expansion joints at the following maximum spacings, unless otherwise indicated on Drawings:
 - a. Exterior Walls: 20 feet on center and within 10 feet on one side of each interior and exterior corner.
 - b. Interior Walls: 30 feet on center.
 - c. At changes in wall height.
 2. Do not continue horizontal joint reinforcement through control and expansion joints.
 3. Install preformed control joint device in continuous lengths. Seal butt and corner joints.
 4. Size control joint in accordance with Section 07900 for sealant performance.
 5. Form expansion joint by omitting mortar and cutting unit to form open space.
- J. Cutting And Fitting:
1. Obtain Architect/Engineer's approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.4 ERECTION TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Maximum Variation From Alignment of Pilasters: 1/4 inch.
- C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- G. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
- H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.
- I. Maximum Variation for Steel Reinforcement:
 - 1. Install reinforcement within the tolerances specified in ACI 530.1 for foundation walls.
 - 2. Plus or minus 1/2 inch when distance from centerline of steel to opposite face of masonry is 8 inches or less.
 - 3. Plus or minus 1 inch when distance is between 8 and 24 inches.
 - 4. Plus or minus 1-1/4 inch when distance is greater than 24 inches.
 - 5. Plus or minus 2 inches from location along face of wall.

3.5 FIELD QUALITY CONTROL

- A. Concrete Masonry Units: Test each type in accordance with ASTM C140.

3.6 CLEANING

- A. Section 017000 - Execution Requirements: Final cleaning.
- B. Remove excess mortar and mortar smears as work progresses.
- C. Replace defective mortar. Match adjacent work.
- D. Clean soiled surfaces with cleaning solution.
- E. Use non-metallic tools in cleaning operations.

3.7 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution Requirements: Requirements for protecting finished Work.
- B. Protect exposed external corners subject to damage.
- C. Protect base of walls from mud and mortar splatter.

- D. Protect masonry and other items built into masonry walls from mortar droppings and staining caused by mortar.
- E. Protect tops of masonry work with waterproof coverings secured in place without damaging masonry. Provide coverings where masonry is exposed to weather when work is not in progress.

END OF SECTION 042016

SECTION 04 22 00 – CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Concrete masonry units (CMU).

1.3 DEFINITIONS

- A. CMU: Concrete masonry unit.
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.
- C. Underwriters' Laboratories, Inc. (UL).

1.4 RELATED WORK

- A. Section 01 45 23 - Testing and Inspecting Services.
- B. Section 05 50 00 – Metal Fabrications. Steel masonry lintels.
- C. Section 07 11 00 – Bituminous Dampproofing.
- D. Section 07 21 00 – Thermal Insulation.
- E. Section 07 92 00 – Joint Sealants.
- F. Section 09 90 00 – Painting and Coatings.
- G. All Sections of Work built-in, adjacent to, or applied to unit masonry work.

1.5 REFERENCES

- A. ASTM International (ASTM)
 - 1. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron & Steel Hardware.
 - 2. A307 - Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - 3. A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 4. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 - 5. C90 - Standard Specification for Loadbearing Concrete Masonry Units.
 - 6. C140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units.
 - 7. C144 - Standard Specification for Aggregate for Masonry Mortar.
 - 8. C150, Standard Specification for Portland Cement.
 - 9. C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
 - 10. C270 - Standard Specification for Mortar for Unit Masonry.
 - 11. C331 - Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
 - 12. C332 - Standard Specification for Lightweight Aggregates for Insulating Concrete.
 - 13. C404 - Standard Specification for Aggregates for Masonry Grout.
 - 14. C476 - Standard Specification for Grout for Masonry.
 - 15. C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

16. C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
17. C979 - Standard Specification for Pigments for Integrally Colored Concrete.
18. D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
19. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
20. E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.6 QUALITY ASSURANCE

- A. Where requirements of this Section are in conflict with requirements noted on the Structural Drawings, the Structural Drawings shall take precedence. Refer to Structural Drawings for information on load-bearing CMU walls.
- B. Fire Performance Characteristics: Where indicated or required, provide materials and construction which are identical to assemblies whose fire endurance has been determined by testing in compliance with ASTM E119 by U.L. or other recognized testing and inspection organization or by other means, acceptable to authority having jurisdiction.
- C. Masonry Cleaning: Workers shall have minimum 5 years of masonry cleaning experience, and shall be approved by cleaner manufacturer prior to application of cleaning material, and shall meet with cleaner manufacturer for demonstration and instructions for use of product prior to application.
- D. Perimeter Walk-Around: Daily perimeter walk-around the exterior side of the masonry by the GC and or masonry Subcontractor at the end of each work day as a visual inspection looking for obvious issues or flaws concerning colors, finishes, workmanship, protection of Work.
- E. Source Limitations:
 1. For Masonry Units: Obtain masonry units of uniform texture and color, or a uniform blend within the accepted ranges for those characteristics, from one (1) manufacturer for each different product required for each continuous surface or visually related surfaces.
 2. For Mortar and Grout Materials: Brands of cementitious materials and admixtures, and the source of supply of sand and aggregates shall remain the same throughout the Work where exposed to view and where not scheduled to receive a subsequently applied finish, i.e. parging, painting, etc., unless directed otherwise in writing by the Architect.
 3. Contractor's Responsibility: Contractor performing Work of this Section shall be responsible for coordinating with others performing work which is built-in or adjacent to unit masonry work.

1.7 SUBMITTALS

- A. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
- B. Sample Panel(s):
 1. Do not start masonry until Architect has approved samples.
 2. Sample panel shall be 6 feet long by 8 feet high showing selected color range and texture, bonding, joint shape, and quality of workmanship. Include an expansion joint, and any specialty details, such as reveals, soldier courses, etc. Include mock-up of installation of thru-wall flashing at foundation sill and lintel above openings, window jambs and sills.
 3. A separate panel for each type of masonry used is required.
Sample panel(s) shall remain at the jobsite until all masonry is completed.
Installed materials shall be visible and integrated into adjacent materials.
 4. Brace and support as required to withstand structural wind loads.

- C. Certification: Submit manufacturer's affidavit that materials used in Project contain no asbestos.
- D. Mortar and Grout Mix Designs: Submit two (2) copies of proposed mortar and grout mix designs to Owner's testing laboratory.

1.8 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 00 – Project Management and Coordination.

1.9 MOCKUPS

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Build mockups for typical exterior and interior walls in sizes approximately 72 inches (1800 mm) long by 72 inches (1800 mm) high by full thickness, including face and backup wythes and accessories.
 - a. Include a sealant filled joint at least 16 inches (400 mm) long in each mockup.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
 - c. Include through wall flashing installed for a 24 inch (600 mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12 inch (300 mm) length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include each type of masonry on one face of interior unit masonry wall mockup.
 - 3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 - 4. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 - 5. Protect accepted mockups from the elements with weather resistant membrane.
 - 6. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 7. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

1.10 TESTS AND INSPECTIONS

- A. Materials and installation of masonry shall be subject to testing and inspection by an independent testing laboratory. Such tests and inspections shall not relieve Contractor of responsibilities for providing materials and procedures which comply with Contract Documents. Promptly remove and replace materials which do not comply.
- B. Owner will select Inspection and Testing Laboratory and will pay for all Work required by Inspection and Testing Laboratory.

1.10 DELIVERY, STORAGE AND PROTECTION

- A. Deliver and store materials in dry protected areas off ground. Keep free of stain or other damage before, during and after installation. Replace any damaged material at no cost to Owner.

- B. During freezing weather, protect masonry units with tarpaulins or other suitable material. Keep free of stain or other damage before, during and after installation. Replace damaged material at no cost to Owner.
- C. Protect reinforcement and accessories from elements.

1.11 SITE CONDITIONS

- A. Cold Weather Protection:
 - 1. No masonry shall be laid when the temperature of the outside air is below 40 degrees F, unless protection measures are employed and pre-approved by the Architect.
 - 2. Protection measures for cold weather erection include maintaining space and masonry unit temperatures of at least 40 degrees F for 48 hours prior to and after erection.
- B. Hot Weather Protection:
 - 1. When the mean daily temperature exceeds 100 degrees F or exceeds 90 degrees F with a wind velocity greater than 8 mph, fog spray all newly constructed masonry until damp, at least three (3) times a day until the masonry is three (3) days old.

1.12 BRACING OF MASONRY DURING ERECTION

- A. All masonry shall be adequately braced at all times during erection.

1.13 COORDINATION

- A. Openings and chases for heating, plumbing, electrical ducts, pipes, and conduits shall be built into masonry walls as required. Provide for installation of bolts, toggles, flashings, beams, anchors, hangers, nailing strips, wall plugs, and frames as required. Consult other trades in advance and make provisions for installation of their work to avoid cutting and patching. Coordinate installation of steel reinforcement for reinforced masonry. Coordinate placement of concrete in masonry beams, lintels, soffits, and pilasters.
- B. Contractor performing Work of this Section shall be responsible for and coordinate with work of Section 07 11 00, Dampproofing Above Grade and all Sections of Work built-in, adjacent to, or applied to unit masonry work.

1.14 WARRANTY

- A. Warrant the Work specified herein for one (1) year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials or workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Noticeable deterioration of unit or mortar finish.
 - 2. Chalking or dusting excessively.
 - 3. Changing color in irregular fashion.
 - 4. Cracking or spalling.
 - 5. Releasing from substrate.
 - 6. Staining or discoloring, including efflorescence.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Specifications are based on products of manufacturers named within the specifications. Other manufacturers must have a minimum of five (5) years experience manufacturing products equal to those specified and comply with requirements of Division 1

regarding substitutions to be considered.

1. Concrete Masonry Units (CMU/Block) Manufacturers: Subject to compliance with requirements, provide products of one of the following:
 - a. Boral Industries Company (Formerly Headwaters Construction Products).
 - b. Featherlite Building Products.
 - c. Texas Building Products, Inc.
 - d. Revels Block & Brick Co., Inc.

2.2 MATERIALS

A. Concrete Masonry Units (CMU/Block):

1. Type/Sizes:
 - a. Exterior exposed block: Split face units with 8 inch by 16 inch face dimensions as shown on drawings or required, 4 inch, 6 inch, and 8 inch depths as indicated on drawings.
 - 1) Color: Architect to select from manufacturers full range or noted on Drawings.
 - 2) Exterior exposed burnished block: Integrally colored face units with 8 inch by 16 inch face dimensions as shown on drawings or required, 4 inch, 6 inch, and 8 inch depths as indicated on drawings.
 - 1) Color: Architect to select from manufacturers full range or noted on Drawings.
 - 3) Interior exposed regular smooth face units: face units with 8 inch by 16 inch face dimensions as shown on drawings or required, 4 inch, 6 inch, and 8 inch depths as indicated on drawings.
 - 2) Color: Architect to select from manufacturers full range or noted on Drawings.
 - 4) Interior exposed solid regular smooth face units double chamfered corners:
 - 1) Size: As shown on drawings.
2. Integral Water Repellant (In exterior exposed CMU): "Dry-Block Block Admixture" integral water repellant admixture as manufacturer by Grace Construction Packaging (GCP), or equal.
3. Specification: Comply with ASTM C90 (Class D-2 (2 hour) and Class B-4 (4 hour)) block at rated walls).
 - a. Aggregate: Lightweight in accordance with ASTM C331.
4. Curing: Rotary kiln process.
5. Provide bullnose units at all outside corners.
6. Provide bond beams, control joints, jambs, lintels, soaps, cap blocks, and fillers to match and compliment block units as shown or required.

B. Mortar:

1. Materials: (Unless stated otherwise on Structural Drawings)
 - a. Portland Cement: ASTM C150, Type 1.
 - b. Hydrated Lime: ASTM C207, TYPE "N", typical. Use TYPE "S" for load-bearing masonry.
 - c. Aggregate: Sand conforming to ASTM C144.
 - d. Water: Clean and potable.
 - e. Admixtures For Mortar:
 - 1) General: Do not use calcium chloride.
 - 2) Concrete Masonry Units: Spectrum Mortar Color or Architect approved equal.
 - 3) Integral Water Repellant (In mortar of exterior exposed CMU): "Dry-Block Mortar Admixture" integral water repellant admixture as manufacturer by Grace Construction Packaging (GCP) or equal. Note: Water repellent block admixture and mortar admixture are not interchangeable.

2. Mix Design: (Proportions by volume) (Unless stated otherwise on Structural Drawings)
 - a. Typical, Non-load bearing masonry
 - 1) Type: ASTM C270, Type "N."
 - 2) Proportions: 1 part cement, 1 part hydrated lime and 6 parts sand to provide a compressive strength of 750 psi in 28 days. Do not use calcium chloride.
 - b. Load bearing structural masonry
 - 1) Type: ASTM C270, Type "S."
 - 2) Proportions: 1 part cement, 1/2 part hydrated lime and 4-1/2 parts sand to provide a compressive strength of 1800 psi in 28 days. Do not use calcium chloride.
- C. Grout:
 1. Materials: (Unless stated otherwise on Structural Drawings)
 - a. Hydrated Lime: ASTM C207, TYPE "S."
 - b. Portland Cement: ASTM C150, Type 1.
 - c. Water: Clean and potable
 - d. Aggregates:
 - 1) Course aggregate shall conform to ASTM C404.
 - 2) Fine aggregate shall conform to ASTM C144.
 2. Mix Design: (Unless stated otherwise on Structural Drawings)
 - a. Comply with ASTM C476 to provide a compressive strength of 2,500 psi in 28 days, unless noted otherwise. Do not use calcium chloride.
 - 1) Fine Grout: Fine grout conforming to ASTM C476 and consisting of 1 part Portland cement, 0 to 1/10 part lime and 2-1/4 to 3 parts sand by volume.
 - 2) Course Grout Mix: Course grout conforming to ASTM C476 and consisting of 1 part Portland cement, 0 to 1/10 part lime and 2-1/4 to 3 parts sand, and 1 to 2 parts course aggregate.
- D. Reinforcement, Anchors and Tie Systems:
 1. General: Reinforcement used in all wythes shall be galvanized after fabrication in accordance with ASTM A153, Class B-2.
 2. Approved Manufacturers include the following:
 - a. Heckmann Building Products
 - b. Hohmann & Barnard, Inc
 - c. Wire-Bond
 3. At solid multiple wythe masonry walls and single wythe masonry walls, (Interior partitions) use #9 gauge truss type reinforcing. Pre-fab corners and tees shall be used at all wall corners and intersections; width shall be two (2) inches less than nominal thickness of walls. Hohmann & Barnard "120 Truss-Mesh" at single wythe; "230 Ladder-Tri-Mesh" at multiple, or Architect approved equal.
 4. At Double Wythe Cavity Walls with Insulation Board: Use Hot-dipped galvanized, #9 gauge truss type with 3/16 inch adjustable pintle wall ties. Width of truss reinforcement shall be 2 inches less than the nominal thickness of wall. 3/16 inch wall tie double eye sections welded at 16 inches o.c. extended as required for insulation thickness. Pre fab corners and tees shall be used at all wall corners and intersections. Hohmann & Barnard "270 Ladder Eye-Wire", or Architect approved equal.
 5. At Masonry Anchored to Steel Spandrel Beam and Columns: Hot-dipped galvanized, No. 315 Anchor and No. 316 Pintle Tie manufactured by Heckmann Building Products, Inc., or Architect approved equal. Anchors detailed on Structural Drawings supersede.
 6. Control Joint Anchor: Equal to Heckmann Building Products, Inc. No. 351 Anchor.
 7. Corrugated Wall Tiles: Not acceptable under any circumstances.
- E. Precast Concrete U-Lintels
 1. Concrete Materials:
 - a. Portland Cement: ASTM C150 Type I or III, gray color.

- b. Aggregates: ASTM C33.
 - c. Water: potable
 - d. Admixtures: Shall not contain calcium chloride or chloride ions.
2. Reinforcing:
- a. Deformed Reinforcement: ASTM A615 Grade 40 or 60.
 - b. Prestressing Strand: ASTM A416 270 ksi LL.
3. Fabrication:
- a. Unless specified otherwise, conform to PCI MNL-116.
 - b. U-lintel units 14 feet in overall length and shorter shall be made of concrete with a minimum strength of 3500 psi at 28 days.
 - c. U-lintel units exceeding 14 feet in overall length shall be made of concrete with a minimum strength of 6000 psi at 28 days and shall be prestressed concrete.
 - d. Units shall be sand block finish except prestressed, 6 inch wide, and 12 inch wide U-lintels shall be smooth form finished.
 - e. Tolerances shall be per PCI MNL-116
 - f. Minor patching in plant is acceptable provided structural adequacy of units is not impaired
4. Acceptable Product/Manufacturer: Cast-Crete High Strength Precast Concrete U-lintels as manufactured by Cast-Crete, Tampa, FL (800) 999-4641, and locally distributed by Boral (formerly Headwaters), (713) 365-9077.
- F. Miscellaneous Materials: (As shown or required)
- 1. Reinforcing Steel: ASTM A615, Grade 60.
 - 2. Forms: Form grade plywood with wood studs and wales as required.
 - 3. Shores: Patented shores of design and manufacture sufficient to safely support imposed loads.
 - 4. Premolded Filler: Fibrous mastic strips containing 35 percent to 50 percent asphaltic impregnation, ASTM D1751.
 - 5. Flashing Cement: "Nerva-plast" cold setting mastic manufactured by Nervastral, Inc., or Architect approved equal.
 - 6. Building Felt: No. 15 asphalt saturated felt, ASTM D226.
 - 7. Dovetail Anchors: 16 gauge galvanized dovetail corrugated masonry anchor, 1 inch x 3-1/2 inch manufactured by Heckman Building Products, Inc., Hohmann & Barnard, Inc., Masonry Reinforcing Corporation of America, or Architect approved equal.
 - 8. Steel Shapes and Plates: As shown on drawings and specified in Section 05 50 00, Metal Fabrications.
 - 9. Headed Stud Anchor: Welded by full-fusion process as furnished by TRW Nelson Stud Welding Division, or Architect approved equal.
 - 10. Bolts: ASTM A307. Furnish with carbon steel washers.
 - 11. Deformed Bar Anchors: Welded by full-fusion process as furnished by TRW Nelson Stud Welding Division, or Architect approved equal.
 - 12. Reinforcing Bars to be Welded: ASTM A706.
 - 13. Cavity Drainage Protection: 2 inch thick by 10 inch high by 5 feet long recycled polyester/polyethylene mesh, trapezoidal-shaped, continuous at foundation, at heads above openings, and shelf angles as indicated on drawings. Provide Mortar Net™ manufactured by Mortar Net Solutions, Burns Harbor, IN; (800) 664-6638, or Architect approved equal.
 - 14. Masonry Color: Iron oxide pigment conforming to ASTM C979 in color(s) selected by Architect, shall be inert, stable to atmospheric conditions, sunfast, weather resistant, alkali resistant, water insoluble, and free of fillers and extenders, as manufactured by ChemSystems, Inc., Davis Colors, Solomon Grind-Chem Service, Inc., or Architect approved equal.

15. Weep Hole Vents: Injection molded vent made from flexible polyvinyl chloride in an offset "T" shape, inserted in head joints, the slotted leg of the vent allows air to pass in and out allows water to weep out and prevents water from penetrating in manufactured by Williams-Goodco, Phone: 800-521-9594 or 248-643-6400 or Email: Wilpro@williamsproducts.net. Weep hole vents shall be sized to match masonry (may require custom sizing).

2.3 MASONRY STRENGTH

- A. Ultimate compressive strength of masonry as required by design and determined by prism tests shall not be less than 1,800 psi, unless stated otherwise in Structural Drawings.

2.4 MASONRY CLEANING MATERIALS

- A. Detergent Cleaner: Bucket and brush hand cleaning method, BIA Technical Notes 20.
- B. Proprietary Acidic Cleaner: Cleaner designed for removing mortar/grout stains, efflorescence, and construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Diedrich Technologies, Inc.
 - b. PROSOCO, Inc.
 - c. AHI Supply.
- C. The following products based on AHI Supply TexClean products are intended as a guide only and does not preclude the contractors use of equal products by listed manufacturers. Consult manufacturer prior to application for any questions or inconsistencies.

| Substrate | Color/Type | Cleaning Solution |
|------------------------|------------------------|---------------------------|
| Brick | Red | Tex Clean Masonry Cleaner |
| | Light | Tex Tral Masonry Cleaner |
| | Dark | Tex Tral Masonry Cleaner |
| | Pavers | Tex Clean Masonry Cleaner |
| | Glazed | Tex Tral Masonry Cleaner |
| CMU | Split Face | Tex Tral Masonry Cleaner |
| | Burnished/Ground Face | Tex Tral Masonry Cleaner |
| Architectural Concrete | Natural Color/Smooth | Tex Tral Masonry Cleaner |
| | Textured | Tex Clean Masonry Cleaner |
| Stone Construction | Cast Stone | Tex Tral Masonry Cleaner |
| | Arriscraft | Tex Tral Masonry Cleaner |
| | Limestone (Unpolished) | Tex Tral Masonry Cleaner |

PART 3 - EXECUTION

3.1 FORMS AND SHORES

- A. Provide forms and shores sufficiently strong and rigid as required to support soffits, beams, and lintels during construction.
- B. Build forms to conform to shape, line, and dimension of masonry members as detailed, substantial and sufficiently tight to prevent leakage of mortar, grout or concrete. Properly brace or tie together so as to maintain position and shape.

3.2 PREPARATION OF MATERIALS

- A. Concrete Masonry Units:
 - 1. Where cutting is required, masonry shall be cut with a sharp masonry saw.
 - 2. Ensure concrete masonry units to receive sand fill are ready for filling and cutouts are protected from material spillage.
- B. Mortar and Grout:
 - 1. Use suitable containers for material measurement. Measuring sand by the shovel is not acceptable.
 - 2. Thoroughly machine mix a minimum of five (5) minutes after all materials are in mixer.
 - 3. Consistency will completely fill all spaces intended to receive grout.
 - 4. Use within 2-1/2 hours of initial mixing.
 - 5. Mortar or grout shall not be used if curing has progressed to yield a stiff consistency.
- C. Reinforcement:
 - 1. Reinforcement shall be free from loose rust and other coatings that would reduce the bond.
 - 2. Cut accurately to length and bend by such methods as will prevent injury to the material.
 - 3. Straighten out kinks or bends.
- D. Flashing:
 - 1. Locations: Install in exterior walls to divert moisture within walls to exterior surfaces.
 - 2. Bed Joints: Coordinate work with Division 4, Masonry. Install flashings between two (2) thin layers of masonry mortar without increasing thickness of mortar joint. Keep outer edge of flashing material back from face of masonry.
 - 3. Adjacent Work: Protect work by masking, covering, or other precautionary methods. Remove protection when no longer necessary.
 - 4. Separate copper flashing from dissimilar materials.
 - 5. Protect membrane flashing from overexposure to direct sunlight.

3.3 INSTALLATION

- A. General:
 - 1. Do not use chipped or cracked concrete masonry units (CMU), where exposed to view.
 - 2. Use masonry saws to cut and fit exposed units.
 - 3. Exposed masonry at exterior corners shall be solid units.
 - 4. Clean surface of masonry smooth and free from projections which might puncture or otherwise damage flashing material.
 - 5. Place through-wall flashing as follows:
 - a. Place on bed of mortar and cover with mortar.
 - b. Provide at steel columns and beams in exterior masonry walls and elsewhere as indicated on the drawings or required.

- c. Install asphalt laminated copper membrane as base flashing at all exterior cavity walls below weep holes.
 - d. Install at material transitions inside exterior cavity walls, roof edge/exterior wall transitions, masonry joints (control/expansion) inside exterior cavity walls, exterior wall sill/weep conditions, exterior door and window frame perimeters, roof deck/exterior wall transitions, exterior wall penetrations (i.e. pipe, conduit, ducts, etc.). Provide membrane at all joints, holes, gaps or openings to ensure a continuously sealed building envelope.
- 6. Lay masonry units plumb, true to line, and with level courses accurately spaced within allowable tolerances.
- 7. Do not furrow bed joints.
- 8. Stop off horizontal run by racking back in each course; toothing is not permitted.
- 9. Adjust units to final position while mortar is soft and plastic.
- 10. If units are displaced after mortar has stiffened, remove, clean joints and units and re-lay with fresh mortar.
- 11. When joining fresh masonry to set or partially set masonry:
 - a. Remove loose masonry units and mortar
 - b. Clean and lightly wet exposed surface of set masonry prior to laying fresh mortar.
- B. Metal Door Frames: Fill jamb frames solid with mortar. Build in anchors.
- C. Lintels and Bond Beams: Provide reinforced unit type, except where steel lintels are shown. Use reinforcing bars as shown on the drawings. Completely fill in lintel block and bond beams with grout. Provide 8 inch bearing at end of lintels.
- D. Corners: Connect corners with No. 9 galvanized wire tie using one tie for each 4 inches of nominal wall thickness.
- E. Partition Tops: Allow space at top of horizontal spanning walls for compressible joint back-up and sealant as specified in Sealant section. Anchor top of walls to deck or structure.
- F. Mortar Beds:
 - 1. Place mortar in a manner which will result in the development of adequate bond between the masonry and the reinforcement.
 - 2. Lay units with full mortar coverage on horizontal and vertical joints in all courses.
 - 3. Provide sufficient mortar on ends of masonry unit to fill head joints.
 - 4. Rock closures into place with head joints thrown against two adjacent masonry units in place.
 - 5. Do not pound corners or jambs to fit stretcher units after setting in place.
 - 6. Where adjustment to corners or jambs must be made after mortar has started to set, remove mortar and replace with fresh mortar.
- G. Mortar Joints and Patterns:
 - 1. Lay CMU in running one-half (1/2) bond pattern, unless noted otherwise.
 - 2. Provide flush joints where concealed from view and where dampproofing is scheduled.
 - 3. Provide standard concave tooled joint where masonry is exposed to view for CMU, typically.
 - 4. All mortar joints to be of consistent size.
 - 5. Provide soldier courses where indicated, refer to the elevations.
 - 6. All horizontal joints shall be concave tooled joint at face of units, unless noted otherwise.
 - 7. Provide raked joints at all exposed burnished cmu locations.
- H. Reinforcement, Anchor and Tie Systems:
 - 1. General:

- a. Completely embedded in mortar or grout.
- b. All reinforcement consisting of bars or wire 1/4 inch or less in diameter embedded in the horizontal mortar joints shall have no less than 5/8 inch mortar coverage from the exposed face.
- c. Veneer anchors at exterior sheathed covered metal stud exterior walls shall be attached on outside face of sheathing using cadmium plated sheet metal screws. Spacing shall be same as stud spacing o.c. horizontally and 16 inches o.c. vertically.
- d. At intersection of all perpendicular masonry walls provide two (2) vertical rows of ladder type reinforcing at 16 inches o.c. vertically.
- e. Weld veneer anchors to structural steel in accordance with manufacturer's recommendations. Touch-up steel shop paint and galvanized coating on anchor with touch-up primer and finish coats to match damaged coating in accordance with manufacturer's recommendations.
- f. In cavity walls with CMU back-up, embed truss type horizontal reinforcement with integral adjustable pintle wall ties every 16 inches o.c. vertically.
- g. Splices in reinforcement: Splices may be made only at such points and in such manner that the structural strength of the member will not be reduced. Lapped splices shall be eight (8) inches. Welded or mechanical connection shall develop the strength of the reinforcement.
- h. Corrugated strap ties shall not be used as veneer anchors at exterior or where subject to moisture. Their use in interior, dry conditions are acceptable.
- i. Place joint reinforcement in the first two (2) bed joints above and the first two (2) bed joints below masonry openings. Extend extra reinforcing two (2) feet beyond jambs.
- j. Provide masonry ties at floor and roof decks as indicated.

I. Flashing:

- 1. Follow manufacturer's instructions for mechanically fastened installation with a termination bar.
- 2. Application Guidelines - Install flashing at the following locations:
 - a. Membrane Flashing: material transitions inside exterior cavity walls, roof edge/exterior wall transitions, masonry joints (control/expansion) inside exterior cavity walls, exterior door and window frame perimeters, roof deck/exterior wall transitions, exterior wall penetrations (i.e. pipe, conduit, ducts, etc.). Provide membrane at all joints, holes, gaps, or openings to ensure a continuously sealed building envelope. Utilize primer on substrates as instructed by manufacturer.
 - b. Copper Flashing: At all horizontal wall flashing, including (but not limited to) exterior wall sill/weep conditions, exterior door and window head/weep conditions, masonry wall cap flashing and masonry wall base flashing.
- 3. Apply substrate primer as instructed by membrane manufacturer to suit condition.
- 4. On Horizontal Surfaces: The flashing shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. The flashing shall be cut flush with the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall, turned up where possible to facilitate drainage through the weepholes, then carried upward across the cavity a minimum of six (6) inches. Flashing will then be secured in back wall with termination bar.
- 5. On Vertical Surfaces: Surfaces receiving the flashing shall be sufficiently spotted with asphalt mastic to hold in place until masonry is set. Secure in back wall with termination bar.
- 6. Foundation Sill Dampproofing: The flashing for foundation sills shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. The flashing shall be cut flush with the exterior face of the wall after being left exposed for inspection purposes only. Flashing

- shall be sloped across the cavity and turned up the wall a minimum of ten (10) inches and secured to back wall with termination bar. Where sill and column meet, flashing shall be brought up a minimum of ten (10) inches up the column.
7. Thru-Wall Flashing: Shall be cut flush with the exterior face of the wall after being left exposed for inspection purposes only. Carry flashing through the wall, turned up where possible to facilitate drainage through the weepholes, then carried upward across the cavity a minimum of six (6) inches, unless noted otherwise, and secure in back wall with termination bar.
 8. Cavity Wall: Flashing shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. Flashing shall be cut flush with the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall and upward across the cavity a minimum of six (6) inches, unless noted otherwise, and secured in the back wall with termination bar. Vertical membrane joints shall be secured with termination bar as instructed by membrane manufacturer.
 9. Heads and Sills: Flashing for heads and sills shall be cut flush with the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall and upward across the cavity a minimum of six (6) inches, unless noted otherwise. Head flashing shall be carried six (6) inches beyond both end of the steel lintel. Both head and sill flashing shall be turned up at the sides to form a pan. All corners shall be folded, NOT CUT. Install weepholes.
 10. Spandrels: Spandrel flashing shall start from the outside toe of the shelf angle, go up the face of the beam and then through the wall, turned up on the inside not less than two (2) inches. Install weepholes.
 11. Parapet or Coping: Flashing for parapets or coping sills shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. Flashing shall be cut flush with the exterior face of the wall after being left exposed for inspection purposes only. Weepholes shall be installed immediately on top of the flashing.
 12. Lengths: Install flashings without longitudinal joints within walls, if possible. If required materials are not available in a single width, join by lapping material minimum two (2) inches and seal joint throughout its length with adhesive.
 13. End Joints: Avoid end joints in flashing. When end joints are necessary, lap flashing minimum six (6) inches and seal joint continuously with adhesive.
 14. Penetrations: Where anchors, pipes, and inserts penetrate flashing, make opening in flashing snug and seal with adhesive.
 15. Reglet Termination: Insert wedge into place and seal carefully with adhesive
 16. Termination Bar: Install flashing with termination bars in accordance with manufacturer's instructions. Provide 3 coursing at all termination bars, typical.
 17. Top Coat: After flashing material is in place (except in masonry joints where bond and mortar is required) trowel full 1/8 inch protective coating or mastic on all flashing faces.
- J. Laying Masonry: Lay units plumb, level, and true to line with full head and bed joints. Butter ends of masonry with sufficient mortar to fill head joints. Do not furrow bed joints. Slope top of bed joint toward center of wall to minimize amount of mortar forced into grout space. Remove mortar, protruding from joints into grout space, before pouring grout.
- K. Reinforcing Bars:
1. Hold vertical bars in position at top and bottom and at intervals not exceeding eight 8 feet-0 inches with a minimum clearance of 1/4 inch from masonry and not less than one (1) bar diameter between bars.
 2. When a foundation dowel is not in alignment with a vertical block cell or pilaster, slope it not more than one (1) horizontal in six (6) vertical to bring it into proper alignment before grouting.
 3. Place horizontal reinforcing bars in continuous masonry courses, consisting of bond-beam or trough block units, and solidly grout in place.
 4. Use straight reinforcing bars except for bends around corners and where bends or hooks are detailed on plans.

5. Lap reinforcing steel 40 bar diameters minimum where spliced and wire together.
- L. Grouting: Where detailed place grout in reinforced masonry beams, walls, columns, and pilasters. All cells and spaces containing reinforcing bars shall be filled with grout. Wherever possible grouting shall be done from inside face of masonry. Exercise extreme care to prevent grout from staining face of masonry. Immediately remove any spilled grout from face and top of masonry.
1. Prior to grouting clean space so that all spaces to be filled with grout do not contain mortar projections greater than 1/2 inch, mortar droppings or other foreign material. Grout shall be placed so all spaces designated to be grouted shall be filled with grout and grout shall be confined to those specific spaces.
 2. Grout materials and water content shall be controlled to provide adequate fluidity for placement, without segregation of constituents and shall be mixed thoroughly.
 3. Between grout pours a horizontal construction joint shall be formed by stopping all wythes at the same elevation and with grout stopping a minimum of 1-1/2 inches below a mortar joint, except at top of wall. Where bond beams occur, stop grout pour a minimum of 1/2 inch below top of masonry.
 4. Reinforcement shall be placed prior to grouting. Bolts shall be accurately set with templates or by approved equivalent means and held in place to prevent movement.
 5. Segregation of grout materials and damage to masonry shall be avoided during the grouting process. Adequately brace masonry to prevent displacement or cracking during grouting operations.
 6. Grout shall be consolidated by mechanical vibrator during placing, before loss of plasticity, in a manner to fill grout space. Grout pours greater than 12 inches shall be reconsolidated by mechanical vibration to minimize voids due to water loss. Grout pours 12 inches or less in height shall be mechanically vibrated, or puddled.
 7. Grout shall not be handled nor pumped utilizing aluminum equipment.
 8. Size and height limitations of grout space or cell shall be as follows:

| GROUT TYPE | GROUT POUR MAX. HEIGHT (FEET) | LEAST CLEAR DIMENSIONS | | CLEANOUTS REQUIRED |
|------------|-------------------------------|----------------------------|---------------------------------|--------------------|
| | | Width of Grout Space (In.) | CMU Cell Dim. Dims. (In. x In.) | |
| Fine | 1 | 3/4 | 1-1/2 x 2 | No |
| Fine | 5 | 1-1/2 | 1-1/2 x 2 | No |
| Fine | 8 | 1-1/2 | 1-1/2 x 3 | Yes |
| Coarse | 1 | 1-1/2 | 1-1/2 x 3 | No |
| Coarse | 5 | 2 | 2-1/2 x 3 | No |
| Coarse | 8 | 2 | 3 x 3 | Yes |

- a. Clear dimension is the cell or grout space width less mortar projections.
- b. Grout space width shall be increased by the horizontal projection of the diameters of horizontal bars within the cross section of the grout space.

9. Place grout in lifts not exceeding 8 feet-0 inches.
- M. Concreting: Supervise placing of concrete in cores of masonry beams and lintels and over masonry soffits where structural concrete is detailed. Report discrepancies or procedures which may adversely affect performance of masonry work.
- N. Sealant Joints:
1. Allow for sealant joints around outside perimeters of exterior doors, window frames and other wall openings.

2. Uniform depth: 3/4 inch.
 3. Uniform width: As shown on the drawings but not less than 1/4 inch.
 4. Provide sample for Architect's approval.
 5. Refers to drawing for locations and details of accent joints.
- O. Movement Joints (Expansion Joints and Control Joints):
1. Locate expansion and control joints as shown on drawings, or if not shown, comply with the following:
 - a. General:
 - 1) Vertical expansion joints shall be placed in the wythe and control joints shall be placed in the concrete masonry wythe, although they do not necessarily have to be aligned.
 - 2) Mortar and joint reinforcement shall not bridge movement joints.
 - 3) Mortar joints which stop at the expansion joint cavity shall be struck flush with the masonry unit, producing a continuous flat surface for the sealant to adhere to.
 - b. Vertical Expansion Joints:
 - 1) Locate expansion joints on long straight walls without openings maximum 25 feet-0 inches.
 - 2) Locate expansion joints at the corner of walls perpendicular to one another. In instances, where the joint is not desired at the corner, the expansion joint shall be located within 10 feet-0 inches of the corner in either wall, but not necessarily both. The spacing of expansion joints around a corner shall not exceed the spacing of expansion joints in a straight wall. For example, if the spacing between expansion joints on a straight wall is 25 feet-0 inches, then the spacing of expansion joints around a corner could be 10 feet-0 inches on one side of the corner and 15 feet-0 inches on the other side. Joint reinforcement may be added around wall corners to provide added tensile strength to the corner, but joint reinforcement shall not bridge the expansion joint.
 - c. Offsets and Setbacks:
 - 1) Locate expansion joints at 10 feet-0 inches maximum on one side of the offset or setback. The spacing of expansion joints around an offset or setback shall not exceed the spacing of expansion joints in a straight wall. See expansion joints at corners of perpendicular walls to one another above for example of spacing.
 - d. Openings (Doors and Windows):
 - 1) Locate vertical expansion joints along the edge or jamb of the opening of windows and doors. Single opening windows and doors under 6 feet-0 inches in width shall have expansion joint on one (1) side of the edge or jamb of the opening as determined by the Architect, unless shown otherwise on drawings. Windows and doors 6 feet-0 inches and over in width shall have expansion joints on both sides of the edge or jamb of the opening.
 - 2) Where masonry above an opening is supported by shelf angles attached to the structure, a vertical expansion joint shall be located alongside the opening, continuing through the horizontal support.
 - 3) Where masonry above the opening is supported by loose lintels (unattached to the structure), special detailing and construction is required. If the expansion joint runs along side the opening, the loose steel lintel shall be allowed to expand independently of the masonry. To accomplish this, form a slip plane with flashing located above and below the angle. A backer rod and sealant shall be installed in front of the toe of

the angle, and space shall be left at the end of the angle. Thus, a pocket will be formed which will allow movement of the steel angle within the masonry. If the joint cannot be built in this manner, then the vertical expansion joint shall not be located alongside the opening, but rather, with Architect's prior approval, the joint shall be located halfway between the openings.

- e. Intersections and Junctions:
 - 1) Locate expansion joints at intersections of masonry walls and walls which serve different functions. If the masonry is not required to be bonded at the intersection, an expansion joint shall be incorporated. Walls which intersect at other than right angles are also vulnerable to cracking at the intersection.
 - 2) Locate expansion joint to separate adjacent walls of different heights to avoid differential movement, especially if the difference is very large.
- f. Parapets:
 - 1) All vertical expansion joints shall be carried through the parapets.
 - 2) Additional expansion joints shall be halfway between those running full height, unless the parapet is reinforced. These additional expansion joints shall continue down to a horizontal expansion joint, or continue to the base of the wall.
- g. Horizontal Expansion Joints:
 - 1) Locate horizontal expansion joints at shelf angles supporting masonry.
- h. Control Joints:
 - 1) Locate CMU control joints directly over concrete slab control joints.
 - 2) Whenever possible, lay out CMU so that control joint will coincide with CMU module (25 feet-0 inch maximum spacing between control joints), unless noted otherwise on drawings.
 - 3) Locate control joints at structural columns to isolate movement from continuing or intersecting walls and columns.
 - 4) Install backer rod and sealant in accordance with manufacturer's instructions.

3.4 ALLOWABLE TOLERANCES

- A. Maximum Variation from Plumb:
 - 1. In lines and surfaces of columns, walls and at rises:
 - a. 1/4 inch in 10 feet (1:480).
 - b. 3/8 inch in 20 feet (maximum).
 - c. 1/2 inch in 40 feet (1:960).
 - 2. For external corners, expansion joints and other conspicuous lines:
 - a. 1/4 inch in 20 feet (maximum).
 - b. 1/2 inch in 40 feet (1:960).
- B. Maximum variation from level:
 - 1. 1/4 inch in any bay or 20 feet.
 - 2. 1/2 inch in 40 feet (1:960).

3.5 REMOVAL OF FORMS AND SHORES

- A. Do not remove shores and forms under reinforced masonry beams, lintels, and soffits until members have hardened sufficiently to carry their own weight and other super imposed loads. Providing that sufficient curing has taken place, leave forms and shores in place as follows:
 - 1. Beam and lintels: Minimum ten (10) days.

- B. Allow 16 hours to elapse after completion of masonry columns and walls before placing floor or roof construction loads on them. Allow an additional 48 hours before applying concentrated loads such as trusses, girders, and beams.

3.6 REPAIRING, POINTING AND CLEANING

- A. All holes in exposed masonry shall be pointed, and defective joints shall be cut out and re-pointed with mortar.
- B. Before applying any cleaning agent to the entire wall, it shall be applied to a sample wall area of approximately 20 square feet, in a location approved by Architect. No further cleaning work may proceed until the sample area has been approved by Architect, after which, the same cleaning materials and method shall be used on remaining wall area. Sash, metal lintels and other corrodible parts shall be thoroughly protected.
Clean all exposed surfaces of new masonry of excess mortar, efflorescence, stains, and job dirt, using materials specified.
 - 1. Clean from bottom up; prevent cleaning materials and rinse water from contacting non-cementitious materials.
 - 2. Clean in accordance with manufacturer's instructions and recommendations, product data, and container label instructions.
 - 3. Mix materials in strict accordance with manufacturers instructions; do not dilute unless permitted by manufacturer.
 - 4. Prevent overspray, wind drift, and splash onto surfaces not to be treated.
 - 5. No high pressure washers are permitted.
 - 6. Low pressure spray for wetting and rinsing is permitted. Pressure should be in the range of 400-1000 psi. Equipment should produce 6-8 gallons of water per minute using a 15-40 degree fan tip (no fan tip less than a 15 degree is allowed).
 - 7. No metal tools or wire brushes are allowed for cleaning of masonry. Use a waste piece of same masonry material for scraping of installed material.

3.7 REPAIR OR REPLACEMENT OF DAMAGED WORK

- A. Imperfect or damaged work, or any material damaged or determined to be defective before final completion and acceptance of the entire job, shall be satisfactorily replaced at Contractor's expense and in conformity with all requirements of drawings and specifications. Removal and replacement of masonry work shall be performed in such a manner as not to impair the appearance or strength of the structure in any way.

3.8 CLEAN-UP AND PROTECTION

- A. Clean up all debris caused by work of this Section, keeping the area clean and neat at all times.
- B. Cover all unfinished work at night against the elements with plastic sheeting, building paper, heavy canvas or other material approved by Architect to prevent water from entering cavities.
- C. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.9 FIELD QUALITY CONTROL AND TESTING

- A. Inspection and Testing Laboratory services shall be in accordance with Section 01 45 23, Testing and Inspecting Services.

END OF SECTION 04 22 00

SECTION 051200 STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Structural shapes.
 - 2. Channels and angles.
 - 3. Hollow structural sections.
 - 4. Structural pipe.
 - 5. Structural plates and bars.
 - 6. Fasteners, connectors, and anchors.
 - 7. Fasteners, connectors, and anchors.
 - 8. Grout.
- B. Related Sections:
 - 1. Section 036000 - Grout: Grout for setting base plates.
 - 2. Section 052100 - Steel Joists.
 - 3. Section 053123 - Steel Roof Deck
 - 4. Section 055000 – Metal Fabrications: Steel Fabrications affecting structural steel work.

1.2 REFERENCES

- A. American Institute of Steel Construction:
 - 1. AISC Code of Standard Practice for Steel Buildings and Bridges.
 - 2. AISC Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings.
 - 3. AISC Load and Resistance Factor Design Specification for Single-Angle Members.
 - 4. AISC Seismic Provisions for Structural Steel Buildings.
 - 5. AISC Specification for Allowable Stress Design of Single-Angle Members.
 - 6. AISC Specification for the Design of Steel Hollow Structural Sections.
 - 7. AISC Specification for Structural Steel Buildings Allowable Stress Design, and Plastic Design.
- B. ASTM International:
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 4. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 5. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 6. ASTM A193/A193M - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - 7. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

8. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
9. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
10. ASTM A449 - Standard Specification for Quenched and Tempered Steel Bolts and Studs.
11. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
12. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
14. ASTM A514/A514M - Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
15. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
16. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
17. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
18. ASTM A588/A588M - Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4-in. (100-mm) Thick.
19. ASTM A618 - Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.
20. ASTM A786/A786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
21. ASTM A847 - Standard Specification for Cold-Formed Welded and Seamless High Strength, Low Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
22. ASTM A852/A852M - Standard Specification for Quenched and Tempered Low-Alloy Structural Steel Plate with 70 ksi (485 MPa) Minimum Yield Strength to 4 in. (100 mm) Thick.
23. ASTM A913/A913M - Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST).
24. ASTM A992/A992M - Standard Specification for Structural Steel Shapes.
25. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
26. ASTM E94 - Standard Guide for Radiographic Examination.
27. ASTM E164 - Standard Practice for Ultrasonic Contact Examination of Weldments.
28. ASTM E165 - Standard Test Method for Liquid Penetrant Examination.
29. ASTM E709 - Standard Guide for Magnetic Particle Examination.
30. ASTM F436 - Standard Specification for Hardened Steel Washers.
31. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
32. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
33. ASTM F1852 - Standard Specification for Twist Off Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

C. American Welding Society:

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 2. AWS D1.1 - Structural Welding Code - Steel.
- D. Research Council on Structural Connections:
1. RCSC - Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- E. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.
 2. SSPC Paint 15 - Steel Joist Shop Paint.
 3. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
 4. SSPC SP 3 - Power Tool Cleaning.
 5. SSPC SP 6 - Commercial Blast Cleaning.
 6. SSPC SP 10 - Near-White Blast Cleaning.

1.3 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings:
1. Indicate profiles, sizes, spacing, and locations of structural members, openings, attachments, and fasteners.
 2. Connections.
 3. Cambers
 4. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Mill Test Reports: Submit indicating structural strength and destructive and non-destructive test analysis.
- D. Manufacturer's Mill Certificate: Certify products meet or exceed specified requirements.
- E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualifications within previous 12 months.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with the following:
1. AISC Code of Standard Practice for Steel Buildings and Bridges.
 2. AISC Code of Standard Practice for Steel Buildings and Bridges. Section 10.
 3. AISC Seismic Provisions for Structural Steel Buildings.
 4. AISC Specification for Structural Steel Buildings Allowable Stress Design, and Plastic Design.
 5. AISC Load and Resistance Factor Design (LRFD) Specification for Structural Steel Buildings.
 6. AISC Specification for the Design of Steel Hollow Structural Sections.
 7. AISC Specification for Allowable Stress Design of Single-Angle Members.
 8. AISC Load and Resistance Factor Design Specification for Single-Angle Members.
 9. RCSC Specification for Structural Joints Using ASTM A 325 or A 490 Bolts.
 10. ASCE 19.

1.5 COORDINATION

- A. Section {013000 - Administrative Requirements}: Requirements for coordination.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

- A. Structural W-Shapes: ASTM A992/A992M; Grade 50
- B. Structural M-Shapes: ASTM A36/A36M; Grade 50
- C. Structural T-Shapes: Cut from structural W-shapes.
- D. Channels and Angles: ASTM A36/A36M.
- E. Round Hollow Structural Sections: ASTM A500, Grade B.
- F. Square and Rectangular Hollow Structural Sections: ASTM A500, Grade B.
- G. Structural Plates and Bars: ASTM A36/A36M.

2.2 FASTENERS, CONNECTORS, AND ANCHORS

- A. Bolts: ASTM A307; Grade A or B.
 - 1. Finish: Unfinished
- B. High Strength Bolts: ASTM A325; Type 1 or ASTM A490; Type 1.
 - 1. Finish: Unfinished
- C. Nuts: ASTM A563 heavy hex type.
 - 1. Finish: Unfinished
- D. Washers: ASTM F436; Type 1, circular
 - 1. Finish: Unfinished
- E. Threaded Rods: ASTM A36/A36M; Grade A.
 - 1. Finish: Unfinished
- F. Forged Structural Steel Hardware:
 - 1. Clevises and Turnbuckles: ASTM A108; Grade 1085.
 - 2. Eye Nuts and Eye Bolts: ASTM A108; Grade 1030.
 - 3. Sleeve Nuts: ASTM A108; Grade 1018.
 - 4. Rod Ends, Yoke Ends and Pins, Cotter Pins, and Coupling Nuts: Carbon steel.

2.3 WELDING MATERIALS

- A. Welding Materials: AWS D1.1; type required for materials being welded.

2.4 ACCESSORIES

- A. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing minimum compressive strength of 7,000 psi at 28 days
- B. Shop and Touch-Up Primer: SSPC Paint 15, Type 1, red oxide.

2.5 FABRICATION

- A. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- B. Fabricate connections for bolt, nut, and washer connectors.
- C. Develop required camber for members.

2.6 FINISH

- A. Prepare structural component surfaces in accordance with SSPC SP 3.
- B. Shop prime structural steel members.
- C. Galvanizing for Structural Steel Members: ASTM A123/A123M; minimum 1.2 oz/sq ft coating thickness; galvanize after fabrication.
- D. Galvanizing for Fasteners, Connectors, and Anchors:
 - 1. Hot-Dipped Galvanizing: ASTM A153/A153M.
 - 2. Mechanical Galvanizing: ASTM B695; Class 50 minimum.

2.7 SOURCE QUALITY CONTROL AND TESTS

- A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Shop test bolted and welded connections as specified for field quality control tests.
- C. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
 - 1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

- B. Verify bearing surfaces are at correct elevation.
- C. Verify anchors rods are set in correct locations and arrangements with correct exposure for steel attachment.

3.2 PREPARATION

- A. Furnish templates for installation of anchor rods and embedments in concrete and masonry work.

3.3 ERECTION

- A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.
- B. Field weld components and shear connectors indicated on Drawings.
- C. Field connect members with threaded fasteners; tighten to snug tight for bearing type connections.
- D. Do not field cut or alter structural members without approval of Architect/Engineer.
- E. After erection, touch up welds and abrasions to match shop finishes.

3.4 GROUT INSTALLATION

- A. Grout [under base plates in accordance with Section 036000.
- B. Shim bearing plates and equipment supports to proper elevation, snug tighten anchor bolts.
- C. Fill void under bearing surface with grout. Install and pack grout to remove air pockets.
- D. Moist cure grout.
- E. Remove forms after grout is set. Trim grout edges to form smooth surface, splayed 45 degrees.
- F. Tighten anchor bolts after grout has cured for a minimum of 3 days.

3.5 ERECTION TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- C. Maximum Offset From Alignment: 1/4 inch.

3.6 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Bolted Connections: Inspect in accordance with AISC specifications.
 - 1. Visually inspect all bolted connections.
 - 2. For Direct Tension Indicators, comply with requirements of ASTM F959. Verify that gaps are less than gaps specified in Table 2.
- C. Welding: Inspect welds in accordance with AWS D1.1.
 - 1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
 - 2. Visually inspect all welds.
 - 3. Ultrasonic Inspection: ASTM E164; perform on all full penetration welds.
 - 4. Liquid Penetrant Inspection: ASTM E165.
- D. Correct defective bolted connections and welds.

END OF SECTION 051200

SECTION 052100 STEEL JOISTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Open web steel joists and shear stud connectors, with bridging, attached seats and anchors.
- B. Related Sections:
 - 1. Section 051200 - Structural Steel: Superstructure framing.
 - 2. Section 053110 - Steel Floor Deck
 - 3. Section 053123 - Steel Roof Deck
 - 4. Section 055000 - Metal Fabrications: Non-framing steel fabrications attached to joists.

1.2 REFERENCES

- A. American Institute of Steel Construction:
 - 1. AISC Seismic Provisions for Structural Steel Buildings.
- B. ASTM International:
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
 - 3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - 6. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - 7. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 8. ASTM F436 - Standard Specification for Hardened Steel Washers.
 - 9. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- D. Steel Joist Institute:
 - 1. SJI K - Standard Specifications for Open Web Steel Joists, K-series.
 - 2. SJI LH/DLH - Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series.
 - 3. SJI JG - Standard Specification for Joist Girders.
- E. SSPC: The Society for Protective Coatings:
 - 1. SSPC - Steel Structures Painting Manual.
 - 2. SSPC SP 1 - Solvent Cleaning.
 - 3. SSPC SP 10 - Near-White Blast Cleaning.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal requirements.
- B. Shop Drawings:
 - 1. Indicate standard designations, configuration, sizes, spacing, locations of joists, joist leg extensions.
 - 2. Joist coding, bridging, connections, attachments.
 - 3. Connection details.
 - 4. Cambers
- C. Welders' Certificates: Submit manufacturer's certificates, certifying welders employed on the Work, verifying AWS qualification within previous 12 months.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with the following:
 - 1. Steel Joist Institute.

1.5 QUALIFICATIONS

- A. Design connections not detailed on drawings under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Texas.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Manufactures: to be certified by SJI
 - 1. Vulcraft Steel Joist
 - 2. SEYCO Joist Company
 - 3. Or approved equal
- B. Open Web Joists Members: SJI Type K. LH Longspan. DLH Deep Longspan and joist Girders.
- C. Nuts: ASTM A563 heavy hex type.
 - 1. Finish: Unfinished
- D. Washers: ASTM F436; Type 1
 - 1. Finish: Unfinished
- E. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A36/A36M.

- F. Welding Materials: AWS D1.1; type required for materials being welded.

2.2 FABRICATION

- A. Furnish bottom and top chord extensions as indicated on drawings.
- B. Fabricate to achieves minimum end bearing of:
 - 1. 2-1/2 inches on steel.
 - 2. 4 inches on masonry.

2.3 FINISH

- A. Shop prime joists and supplementary framing members. Do not prime surfaces that will be fireproofed.
- B. Prepare joist component surfaces in accordance with SSPC SP 2.

2.4 SOURCE QUALITY CONTROL AND TESTS

- A. Furnish shop testing and analysis of steel sections.
- B. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
 - 1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.

3.2 ERECTION

- A. Erect and bear joists on supports.
- B. Allow for erection loads. Install sufficient temporary bracing to maintain framing safe, plumb, and in alignment.
- C. Coordinate placement of anchors in masonry construction for securing bearing plates.
- D. After joist alignment and installation of framing, field weld joist seat to bearing plates or angles.
- E. Position and field weld joist chord extensions and wall attachments as detailed.
- F. Frame floor and roof openings greater than 18 inches with supplementary framing.

- G. Do not permit erection of decking until joists are bridged, and secured or until completion of erection and installation of permanent bridging and bracing.
- H. Do not field cut or alter structural members without approval of Architect/Engineer.
- I. After erection, prime welds, abrasions, and surfaces not shop primed

3.3 ERECTION TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Maximum Variation From Plumb: ¼ inch.
- C. Maximum Offset From Alignment: 1/4 inch.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Field inspect members, connections, welds, and tightening of high strength bolts in slip-critical connections.

END OF SECTION 052100

SECTION 053123 STEEL ROOF DECK

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel roof deck and accessories.
 - 2. Bearing plates and angles.
- B. Related Sections:
 - 1. Section 033000 - Cast-in-Place Concrete.
 - 2. Section 035216 – Lightweight Insulating Concrete.
 - 3. Section 051200 - Structural Steel.
 - 4. Section 052100 - Steel Joists.

1.2 REFERENCES

- A. American Society of Civil Engineers:
 - 1. ASCE 3 - Standard Practice for the Construction and Inspection of Composite Slabs.
- B. ASTM International:
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 4. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- D. Steel Deck Institute:
 - 1. SDI 29 - Design Manual for Composite Decks, Form Decks and Roof Decks.
- E. SSPC: The Society for Protective Coatings:
 - 1. SSPC Paint 15 - Steel Joist Shop Paint.

1.3 PERFORMANCE REQUIREMENTS

- A. Design metal deck in accordance with SDI 29 Design Manual and ASCE 3.
- B. Calculate to structural working stress design and maximum vertical deck deflection of 1/240.
- C. Design deck with maximum lateral diaphragm deflection of 1/500 of story height.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal requirements.
- B. Shop Drawings: Indicate deck plan, support locations, Projections, openings and reinforcement, pertinent details, and accessories.
- C. Product Data: Submit deck profile characteristics and dimensions, structural properties, and finishes
- D. Manufacturer's Installation Instructions: Submit manufacturer's installation instructions.
- E. Manufacturer's Certificates: Certify Products meet or exceed specified requirements.
- F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ASCE 3 for composite decks.

1.6 QUALIFICATIONS

- A. Design deck layout, spans, fastening, and joints under direct supervision of Professional Engineer experienced in design of this Work and licensed. In State of Texas.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Cut plastic wrap to encourage ventilation.
- C. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Sheet Steel: ASTM A653, Grade 33 Structural Quality; with G90 galvanized coating conforming to ASTM A525.
- B. Bearing Plates or Angles: ASTM A36 steel.
- C. Welding Materials: AWS D1.1.

2.2 FABRICATION

- A. Metal Deck: Sheet steel, configured as follows:
 - 1. Span Design: multiple
 - 2. Minimum Metal Thickness Excluding Finish: 22 gage.
 - 3. Minimum Allowable Diaphragm Shear: 250 plf.

- 4. Nominal Height: 1-1/2 inch
- 5. Side Joints: lapped

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.

3.2 INSTALLATION

- A. Erect metal deck in accordance with SDI Manual.
- B. Bear deck on steel supports with 1-1/2 3 inch minimum bearing. Align and level.
- C. Fasten ribbed deck to steel support members at ends and intermediate supports with as indicated on drawings.
- D. Weld in accordance with AWS D1.1.
- E. Seal deck joints, laps, ends, and penetrations with sealant to achieve permanent air seal consistent with air barrier system specified in Section 07270.
- F. Reinforce steel deck openings from 6 to 18 inches in size with 2 x 2 x 1/4 inch steel angles. Place framing angles perpendicular to flutes; extend minimum two flutes beyond each side of opening and mechanically attach to deck at each flute.
- G. Install wet concrete stops at roof edge upturned to top surface of slab to contain wet concrete. Install stops of sufficient strength to remain stationary under wet concrete without distortion.
- H. Install sheet steel closures and angle flashings to close openings between deck and walls, columns, and openings.
- I. Position roof sump pans with flange bearing on top surface of deck. Fusion weld at each deck flute.
- J. Place metal cant strips in position and mechanically attach.
- K. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up prime paint.

3.3 FIELD QUALITY CONTROL

- A. Welding: Inspect welds in accordance with AWS D1.1.

END OF SECTION 053123

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Steel framing and supports for overhead doors and grilles.
 - 2. Steel framing and supports for countertops.
 - 3. Steel framing and supports for mechanical and electrical equipment.
 - 4. Shelf angles.
 - 5. Metal ladders.
 - 6. Metal bollards.
 - 7. Pipe, downspout guards.
 - 8. Abrasive metal nosings, treads, and thresholds.
 - 9. Metal downspout boots.
 - 10. Steel weld plates and angles for casting into concrete for applications.
 - 11. Accessories necessary for a coordinated and complete installation.

1.3 DEFINITIONS

- A. Comparable Product: Product demonstrated and approved through submittal process, or where indicated as a produce substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ladders and countertop supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance of Ladders: Provide ladders and landings capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- C. Structural Performance:
 - 1. Countertops and Vanities: Provide countertop and vanity framing capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections, or of exhibiting excessive deflections in any of the components making up the countertops and vanities:
 - a. All deadloads.
 - b. 500 pound live load placed on the countertop and vanity.
 - c. Deflection at Midspan: L/1000 times span or 1/8 inch whichever is less.
- D. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.5 SUBMITTALS

- A. Product Data: Submit data for miscellaneous metal fabrications and paint, coatings, and grout accessories.
- B. Shop Drawings: Submit shop drawings detailing the fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 1. For installed products indicated to comply with design loads, include structural analysis data, for information only, signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Welding certificates.
- E. Paint Compatibility Certificates: Submit manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Building Code: Comply with applicable requirements of the IBC for metal fabrications.
 2. Welding: Qualify procedures and personnel according to the following:
 - a. AWS D1.1/D1.1M Structural Welding Code - Steel.
 - b. AWS D1.2/D1.2 M Structural Welding Code - Aluminum.
 - c. AWS D1.6/D1.6M Structural Welding Code - Sheet Steel.
 - d. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fabricator/Installer Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project for a minimum of 5 years, with a record of successful in service performance, with sufficient production capacity to produce required units without causing delay in the Work.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal fabrications that are similar to those indicated in material, design, and extent.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 2. Provide allowance for trimming and fitting at site.

1.8 STORAGE, DELIVERY AND HANDLING

- A. Store metal fabrications in a dry, well ventilated, weathertight place. Deliver and handle so as to prevent any type of damage to the fabricated Work.

1.9 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other Work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. As scope and performance documents, the Drawings and Specifications do not necessarily indicate or describe all the work required for the performance and completion of the Work. Contracts will be let on the basis of such documents with the understanding that the Contractor shall furnish and install the items required for proper completion of the Work without adjustment to price or schedule. Work shall be of sound, quality construction and the Contractor shall be solely responsible for the inclusions of adequate labor and materials to cover the proper and timely fabrication and installation of the miscellaneous metal items indicated, described, or implied.
- B. As a performance specification, the criteria for the solution of structurally sound miscellaneous metal items indicated on the Drawings or specified herein are the sole purpose of defining the design intent and performance requirements. The details shown are intended to emphasize the acceptable profiles and performance requirements for this Project. To avoid any misunderstanding or lack of interpretation, the Contractor is hereby advised that the responsibility for the miscellaneous metal items are totally his and that designs and resolutions proposed in the Contractor's shop drawings, structural calculations, and related documentation shall be demonstrated throughout the Work and warranty period specified or required.
- C. Design proposal submissions which follow exactly the details indicated on the Drawings, will not relieve the Contractor of his responsibility for the design, fabrication, erection, or performance of the Work of this Section.
- D. In the event of a controversy over the design, the decision of the Architect will take precedence.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless Steel Bars and Shapes: ASTM A 276, Type 304.

- E. Rolled Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- F. Rolled Stainless Steel Floor Plate: ASTM A 793.
- G. Steel Tubing: ASTM A 500/A 500M, cold formed steel tubing.
- H. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- I. Zinc Coated Steel Wire Rope: ASTM A 741.
 - 1. Wire Rope Fittings: Hot dip galvanized steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- J. Slotted Channel Framing: Cold formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 inches by 1-5/8 inches (41 mm by 41 mm).
 - 2. Material: Galvanized steel, ASTM A 653/A 653M, commercial steel, Type B. with G90 (Z275) coating; [0.108 inch (2.8 mm) nominal thickness.
 - 3. Cold Formed Metal Channels: Flange edges returned toward web and with 9/16 inch (14.3 mm) wide slotted holes in webs at 2 inches (51 mm) o.c.
 - 4. Width of Channels: 1-5/8 inches (41 mm).
 - 5. Depth of Channels: Indicated on Drawings.
 - 6. Metal and Thickness: Galvanized steel complying with ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108 inch (2.8mm) nominal thickness.
 - 7. Finish: Hot dip galvanized after fabrication.
- K. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- L. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
- M. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
- N. Aluminum Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- O. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- P. Fasteners: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum.
 - 2. Provide stainless steel fasteners for fastening stainless steel.
 - 3. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
 - 4. Steel Bolts and Nuts: Regular hexagon head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.
 - 5. Stainless Steel Bolts and Nuts: Regular hexagon head annealed stainless steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy.
 - 6. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

- a. Hot dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
 7. Anchors: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
 8. Cast in Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot dip galvanized per ASTM F 2329.
 9. Slotted Channel Inserts: Cold formed, hot dip galvanized steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee head bolts, complete with washers and nuts, all zinc plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.
- Q. Miscellaneous Materials:
1. Shop Primer for Ferrous Metal: Universal primer, organic zinc rich primer, complying with SSPC-Paint 20 and compatible with topcoat. Provide 10-99 (red) or 10-09 (gray) by Tnemec Company.
 2. Universal Shop Primer: Fast curing, lead and chromate free, universal modified alkyd primer and compatible with topcoat. Use primer containing pigments that make it easily distinguishable from zinc rich primer.
 3. Water Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel and compatible with topcoat.
 4. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc coated metal and compatible with finish paint systems indicated.
 5. Galvanizing Repair Paint: High zinc dust content paint for reglazing welds in steel, complying with SSPC-Paint 20. Provide Tnemec-Zinc 90-97 by Tnemec Company.
 6. Bituminous Paint: Cold applied asphalt emulsion complying with SSPC-Paint 12, containing no asbestos fibers, or cold applied asphalt emulsion complying with ASTM D 1187 ASTM D 1187/D 1187M.
 7. Nonshrink, Nonmetallic Grout: Factory packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
 8. Concrete Materials and Properties: Composed of ASTM C150 Type I Portland cement, ASTM C33 sand and coarse aggregates and potable water to produce a low slump mix suitable for placement. Grade coarse aggregate from 1/8" with at least 95 % passing a 3/8" sieve and not more than 10% passing a No. 8 sieve. Fill shall be proportioned to provide a minimum 28 day compressive strength of 3000 psi (20 MPa).

2.2 FABRICATION

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
 2. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing Work.
 3. Form exposed Work with accurate angles and surfaces and straight edges.
 4. Weld corners and seams continuously to comply with the following:

- a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - b. Obtain fusion without undercut or overlap.
 - c. Remove welding flux immediately.
 - d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
 5. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
 6. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
 7. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
 8. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
 9. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 inch by 1-1/2 inches (3.2 mm by 38 mm), with a minimum 6 inch (150 mm) embedment and 2 inch (50 mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.
- B. Miscellaneous Framing and Supports: Provide steel framing and supports necessary to complete the Work and which are not a part of the structural framework, including but not limited to framing and supports for countertop and vanities and tube framing for partial height walls, CMU partition head supports, mechanical and electrical equipment.
1. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - a. Fabricate units from slotted channel framing where indicated.
 - b. Furnish inserts for units installed after concrete is placed.
 2. Countertop and Vanity Framing: Custom fabricate countertop and vanity framing, using steel shapes and plates, and cold finished mild steel bars at exposed conditions, for support framing and plywood, to the thicknesses, sizes and shapes shown, and as required to produce Work of adequate strength and durability, without objectionable deflections. Use proven details of fabrication, as required, to achieve proper assembly and alignment of the various components of the Work.
 3. CMU Partition Head Supports: Fabricate supports from 4" x 4" x 1/4" x 36" (100 mm by 100 mm by 6 mm by 900 mm) long structural steel angles. Drill supports a maximum of 12 inches (300 mm) o.c. to receive expansion bolts.
 4. Galvanize miscellaneous framing and supports at exterior locations; prime paint miscellaneous framing and supports at interior locations.
- C. Shelf Angles: Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4 inch (19 mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
1. Provide mitered and welded units at corners.
 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.

3. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
 4. Galvanize and prime shelf angles located in exterior walls.
 5. Prime shelf angles located in exterior walls with zinc rich primer.
 6. Furnish wedge type concrete inserts, complete with fasteners, to attach shelf angles to cast in place concrete.
- D. Ladders: Comply with ANSI A14.3. For elevator pit ladders, comply with ASME A17.1/CSA B44
1. Aluminum Ladders:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) ACL Industries, Inc.
 - 2) Alco-Lite Industrial Products.
 - 3) Halliday Products.
 - 4) O'Keeffe's Inc.
 - 5) Precision Ladders, LLC.
 - 6) Royalite Manufacturing, Inc.
 - 7) Thompson Fabricating, LLC.
 - b. Space siderails 16 inches (406 mm) apart unless otherwise indicated.
 - c. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
 - d. Rungs: Extruded aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
 - e. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
 - f. Provide platforms as indicated fabricated from pressure locked aluminum bar grating supported by extruded aluminum framing. Limit openings in gratings to no more than 1/2 inch (12 mm) in least dimension.
 - g. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted aluminum brackets.
 - h. Provide minimum 72 inch (1830 mm) high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.3 MISCELLANEOUS STEEL TRIM

- A. Miscellaneous Steel Trim: Unless otherwise indicated, fabricate units from structural steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
1. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other Work.
 - a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c.
 2. Cast in Pit Angles and Edge Angles: Provide edge angles, and pit angles, fabricated from angles of size as shown, or required, with welded on stud anchors spaced 24 inches (600 mm) on center. Provide pit and edge angles in as long lengths as possible. Miter and weld corners and provide splice plates for alignment between sections.
 3. Galvanize miscellaneous steel trim.

2.4 PIPE BOLLARDS

- A. Pipe Bollards: Fabricate metal bollards from Schedule 40 steel pipe or 1/4 inch (6.4 mm) wall thickness rectangular steel tubing.

1. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
2. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
3. Where installation on structural slab or existing paving.
4. Fabricate bollards with 3/8 inch (9.5 mm) thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4 inch (19 mm) anchor bolts.
 - a. Where bollards are anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
5. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4 inch (6.4 mm) thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.

2.5 PIPE, DOWNSPOUT GUARDS

- A. Fabricate pipe, downspout guards from 3/8 inch (9.5 mm) thick by 12 inch (300 mm) wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2 inch (50 mm) clearance between pipe and pipe guard. Drill each end for two 3/4 inch (19 mm) anchor bolts.
- B. Galvanize and prime pipe, downspout guards.

2.6 ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

- A. Cast Metal Units: Cast aluminum with an integral abrasive, as cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Safety Tread Co., Inc.
 - b. Barry Pattern & Foundry Co., Inc.
 - c. Nystrom, Inc.
 - d. Granite State Casting Co.
 - e. Safe-T-Metal Company, Inc.
 - f. Wooster Products Inc.
 2. Nosings: Cross hatched units, 4 inches (100 mm) wide with 1 inch (25 mm) lip, for casting into concrete.
 3. Treads: Cross hatched units, full depth of tread with 3/4 inch by 3/4 inch (19 mm by 19 mm) nosing, for application over bent plate treads or existing stairs.
 4. Thresholds: Fluted saddle type units, 5 inches (125 mm) wide by 1/2 inch (12 mm) high, with tapered edges.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches (100 mm) from ends and not more than 12 inches (300 mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
 1. Provide two rows of holes for units more than 5 inches (125 mm) wide, with two holes aligned at ends and intermediate holes staggered.
- D. Apply bituminous paint to concealed surfaces of cast metal units.

- E. Apply clear lacquer to concealed surfaces of extruded units.

2.7 METAL DOWNSPOUT BOOTS

- A. Downspout Boot: Provide downspout boots made from aluminum in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
 - 1. Basis of Design Manufacturer: Piedmont Manufacturing or comparable product approved by Architect.
 - 2. Outlet: Vertical, to discharge into pipe.

2.8 LOOSE BEARING AND LEVELING PLATES

- A. Loose Bearing and Leveling Plate: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
 - 1. Galvanize plates.

2.9 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch (3mm) maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch (1.5mm).
- C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5mm).
- D. Maximum Bow: 1/8 inch (3mm) in 48 inches (1.2m).
- E. Maximum Deviation From Plane: 1/16 inch (1.5mm) in 48 inches (1.2m).

2.10 FINISHES

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surfaces.

2.11 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 4. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- F. Stainless Steel Finishes: Remove tool and die marks and stretch lines or blend into finish.
1. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
 2. Bright, Directional Polish: No. 4 finish.
 3. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.12 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.
1. 1. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- C. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

- A. Fill metal capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.1 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch (6mm) per story, noncumulative.
- B. Maximum Offset from True Alignment: 1/4 inch (6mm).
- C. Maximum Out of Position: 1/4 inch (6mm).

3.2 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0 mil (0.05 mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 90 00.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00

SECTION 05 51 19 - SLIP RESISTANT METAL GRATINGS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Slip resistant metal fabrications.

1.3 RELATED SECTIONS

- A. Section 05 50 00 – Miscellaneous Metals

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C 633 – Adhesion or Cohesive Strength of Flame-Sprayed Coatings.
 - 2. ASTM E 140 – Hardness Conversion Tables for Metals.
 - 3. ASTM E 384 – Microhardness of Materials.

1.5 SUBMITTALS

- A. Comply with Section 01 33 00 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data.
- C. Shop Drawings: Submit manufacturer's shop drawings showing slip-resistant fabrications, sizes, dimensions, manufacturer's factory-applied finishes, fastening, and installation details.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store material in a clean, dry area in accordance with manufacturer's instructions.
- C. Handling: Protect materials, surfaces, and finishes during handling and installation to prevent damage to product and adjacent construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER/PRODUCT

- A. Specifications are based on Model SL manufactured by PRECISION Ladders, LLC, Morristown, TN; (800)225-7814. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 regarding substitutions to be considered.

2.2 MATERIALS

- A. Non-slip aluminum extruded planking by SlipNOT Safety Flooring, Division of W.S. Molnar Company, 2545 Beaufait Street, Detroit, Michigan 48207, (800) 754-7668, www.slipnot.com
 - 1. Type: As indicated on drawings.
 - 2. Size: As indicated on drawings.

2.3 FABRICATION

- A. Aluminum surface on aluminum substrate:
 - 1. Type: Anti-slip, aluminum surface on aluminum substrate.
 - 2. Surface Texture: Grade 2 – Medium.
 - 3. Surface: Anti-slip aluminum surface consisting of aluminum oxide particles 8 to 10 matrix.
 - 4. Bond Strength ASTM C 633: 2,000 psi. minimum.
 - 5. Coefficient of Friction: 0.6 minimum.
 - 6. UL Listed: Slip-resistant.

2.4 FACTORY APPLIED FINISHES

- A. Mill: Unfinished.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examination: Examine areas to receive slip-resistant metal fabrications. Notify Architect if areas are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

3.2 INSTALLATION

- A. Install slip-resistant metal fabrications at locations shown on drawings and in accordance with manufacturer's instructions.
- B. Install slip-resistant metal fabrications level, square, rigid, with flush installation.
- C. Fasten slip-resistant metal fabrications to support steel as indicated on the drawings.
- D. Repair damaged factory-applied finishes as directed by Owner/Architect.
- E. Replace defective or damaged slip-resistant metal fabrications as directed by Owner/Architect.

3.3 CLEANING

- A. Clean work area of debris.
- B. Clean exposed surfaces of slip-resistant metal fabrications of dirt, grease and other foreign materials detrimental to good appearance.

END OF SECTION 05 57 19

SECTION 05 52 00 – METAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Stainless steel pipe and tube railings.
 - 2. Accessories necessary for a complete installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer licensed in the State of Texas and experienced in the design of railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C, material surfaces).

1.4 SUBMITTALS

- A. Product Data: Technical data for railings and the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of connecting and finishing members at intersections.

- D. Delegated design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Qualification Data: For testing agency.
- F. Mill Certificates: Signed by manufacturers of stainless steel products certifying that products furnished comply with requirements.
- G. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- H. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- I. Evaluation Reports: For post installed anchors, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable provisions of the IBC for railings.
 - 2. Welding Qualifications: Qualify procedures and personnel according to the following:
 - a. AWS D1.6/D1.6M Structural Welding Code - Stainless Steel.
- B. Source Limitations: Obtain each type of railing from single source from single manufacturer.

1.6 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following

1. Stainless Steel Pipe and Tube Railings:
 - a. Blum, Julius & Co., Inc.
 - b. Paragon Aquatics.
 - c. Stainless Fabricators, Inc.
 - d. Tubular Specialties Manufacturing, Inc.
 - e. Tuttle Railing Systems.
 - f. Wagner, R & B, Inc.
- B. Metal Surfaces: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2 inch (38 mm) clearance from inside face of handrail to finished wall surface.
- D. Stainless Steel:
 1. Tubing: ASTM A 554, Grade MT 304.
 2. Pipe: ASTM A 312/A 312M, Grade TP 304.
 3. Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20.
 4. Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.
 5. Stainless Steel braided cabling, 3/16" thickness, Type 304.
- E. Fasteners: Provide the following:
 1. Stainless Steel Railings: Type 316 stainless steel fasteners.
 2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.
 3. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
 4. Fasteners for Interconnecting Railing Components:
 - a. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - b. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - c. Provide tamper resistant flat head machine screws for exposed fasteners unless otherwise indicated.
 5. Post Installed Anchors: Torque controlled expansion anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
 - a. Material for Interior Locations: Carbon steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
 - b. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).
- F. Miscellaneous Materials:
 1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

- a. For [aluminum] [and] [stainless steel] railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Bituminous Paint: Cold applied asphalt emulsion complying with SSPC-Paint 12, containing no asbestos fibers, or cold applied asphalt emulsion complying with ASTM D 1187 ASTM D 1187/D 1187M.
3. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.2 FABRICATION

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove flux immediately.
 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- K. Form Changes in Direction:

1. As detailed.
- L. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- M. Close exposed ends of railing members with prefabricated end fittings.
- N. Provide wall returns at ends of wall mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- Q. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.
- R. For removable railing posts, fabricate slip fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- S. Stainless Steel cabling run horizontally at 4 inch on center.
- T. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open sided floors and platforms. Fabricate to dimensions and details indicated.

2.3 FINISHES

- A. Stainless Steel Finishes:
 1. Remove tool and die marks and stretch lines, or blend into finish.
 2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
 3. Directional Satin Finish: No. 4.
 4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in place construction.

3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

- A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material and attached to post with set screws.

- D. Leave anchorage joint exposed with 1/8 inch (3 mm) buildup, sloped away from post.
- E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members:
 - 1. For stainless steel pipe railings, weld flanges to post and bolt to supporting surfaces.
- F. Install removable railing sections, where indicated, in slip fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.
- C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.
 - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
 - 4. For steel framed partitions, use hanger or lag bolts set into [fire retardant treated] wood backing between studs. Coordinate with stud installation to locate backing members.
 - 5. For steel framed partitions, use self tapping screws fastened to steel framing or to concealed steel reinforcements.
 - 6. For steel framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 ADJUSTING AND CLEANING

- A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0 mil (0.05 mm) dry film thickness.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 05 52 00

SECTION 06 20 00 - FINISH CARPENTRY AND MILLWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Providing all finish carpentry items including, but not limited to:
 - 1. Finish Carpentry.
 - 2. Millwork and Cabinetry.
 - 3. Plastic Laminate.
 - 4. Casework Hardware.
 - 5. Ballet Bars.
 - 6. Miscellaneous Millwork.
- B. Installation of:
 - 1. Door hardware.
 - 2. Plastic laminate faced wood doors.

1.3 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI A156.9 - Cabinet Hardware
 - 2. ANSI A161.1 - Woodwork Testing Standards
 - 3. ANSI A208.1 - Mat-Formed Wood Particleboard.
- B. Architectural Woodwork Institute:
 - 1. AWI - Quality Standards Illustrated.
- C. National Electrical Manufacturers Association:
 - 1. NEMA LD 3 - High Pressure Decorative Laminates.

1.4 PERFORMANCE REQUIREMENTS

- A. Unless otherwise indicated, perform work in accordance with AWI "Quality Standards Illustrated", Custom Grade, except where specification exceeds those standards, the more stringent shall govern.
- B. Fabricate millwork and cabinetry in accordance with ANSI A161.1, NEMA LD3, and general static load testing performed and certified by an independent testing agency, covering the following areas of product performance, with these minimum results:
 - 1. Base cabinet construction/racking test: 800 lbs.
 - 2. Cabinet front joint loading test: 425 lbs.
 - 3. Wall cabinet static load test: 2,000 lbs.
 - 4. Drawer front joint loading test: 600 lbs.
 - 5. Drawer construction/static load test: 750 lbs.
 - 6. Cabinet adjustable shelf support device/static load test: 300 lbs.
- C. Shelf Loading: Comply with loading/deflection standards of the Composite Panel Association.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's preprinted product information for all hardware proposed on the project.
 - 3. Manufacturer's preprinted maintenance instructions for the casework hardware.
- B. Shop Drawings:
 - 1. Indicate size, material and finish.
 - 2. Show locations and installation procedures, including hardware, sinks, service fixtures, trim and other pertinent data for each unit.
- C. Certification: Provide manufacturer's certification that casework has been fabricated and installed according to AWI "Custom" Grade guidelines or better.
- D. Samples: Two (2) each, 6 inch by 6 inch by 3/4 inch sample of specified particleboard core with grade stamp for use as verification of installed product.
- E. Closeout:
 - 1. Record Drawings: indicate revisions to original drawings and shop drawings
 - 2. Manufacturer contact names, addresses and phone numbers.
 - 3. Finish Material Schedule: names and color numbers of laminates and stains.
 - 4. Keys: Provide additional master key for each room and additional locksets totaling one percent of total project for attic stock.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Minimum of five (5) years experience in providing manufactured casework systems for similar types of projects, produce evidence of financial stability, bonding capacity, and adequate facilities and personnel required to perform on this project.
- B. Delivery conference: 48 hours prior to delivery, notify Architect of delivery date and time. At the Architect's discretion, a representative of the Architect may be present at the time of delivery. Casework not conforming to the specified requirements, as reasonably determined by the Architect's representative, shall be removed and returned to manufacturer for repair or replacement at no additional cost to the Owner or increase in time.

1.7 PRE-INSTALLATION CONFERENCE

- A. Section 01 31 00 – Project Management and Coordination.

1.8 PRODUCT HANDLING

- A. Deliver completed laminate clad casework, countertops and related products only after wet operations in building are completed. Store in ventilated place, protected from the weather, with relative humidity range of 20 to 50 percent.
- B. Protect finished surfaces from soiling and damage during handling and installation with a protective covering.

1.9 JOB CONDITIONS

- A. Environmental Requirements: do not install casework until permanent HVAC systems are operating and temperature and humidity have been stabilized for at least one (1) week.
 - 1. Manufacturer/Supplier shall advise Contractor of temperature and humidity requirements for architectural casework installation areas.
 - 2. After installation, control temperature and humidity to maintain relative humidity between 25 and 55 percent.
- B. Conditions: Do not store or install casework in building until concrete, masonry, and drywall/plaster work is dry.

1.10 COORDINATION

- A. Coordinate the Work of this Section with plumbing work specified in Division 15. Coordinate sink opening construction with sinks specified in Division 15.
- B. Coordinate location of blocking in walls for installation and support of wall cabinets.

1.11 WARRANTY

- A. Warranty the work specified herein for five (5) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to the following:
 - 1. Rough or difficult operation, or loose or missing parts.
 - 2. Delamination of surfaces.
 - 3. Noticeable deterioration of finish.
 - 4. Warped or misaligned surfaces or telegraphing of subsurface imperfections.

PART 2 - PRODUCTS

2.1 MILLWORK MANUFACTURERS

- A. Manufacturers listed below are certified by AWI Quality Certification Program and are listed for the Contractor's convenience only and shall not preclude the Contractor from using other manufacturers, provided they produce equivalent products of the type specified for the scope and size of the Project. Other manufacturers must have experience manufacturing products meeting or exceeding the specifications and must comply with the criteria specified in paragraph 1.6 above and with Division 1 requirements regarding substitutions.
 - 1. Casework:
 - a. Ameritek Design Inc.; (281) 442-7767.
 - b. Calmar Manufacturing Co., Inc.; (563) 562-3261.
 - c. Case Systems, Inc.; (989) 496-9510.
 - d. Global Casework Manufacturing, Inc.; (281) 494-6181.
 - e. Imperial Mill & Fixture, Inc.; (361) 883-4630.
 - f. Jericho Woodworks; (281) 969-7947.
 - g. Jim R. Reynolds & Associates, Inc.; (281) 350-1133.
 - h. MGC Millwork, LP; TX (713) 772-0894.
 - i. South Texas Woodmill, Inc., Brownsville, TX; (956) 831-3304.
 - j. Stevens Industries, Inc.; (217) 540-3100.
 - k. Terrill Manufacturing Co.; (915) 655-7133.
 - l. TMI Systems Design Corp.; (701) 225-6716.
 - m. Victoria Cabinetworks; (361) 578-0263.
 - n. Alpha Omega Casework LLC; (512) 365-1776.

2.2 MILLWORK MATERIALS

- A. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD3, and the following requirements:
1. Exterior Color Selection Available:
 - a. Architect to select from minimum of 250 selections available, including wood grain patterns and solid colors.
 - b. Provide 5 different colors available per project.
 - c. If laminate has wood grain, direction of grain shall be vertical on door, end panels, fascia panels, and exposed backs; horizontal on drawer faces, aprons, and top rails.
 2. Laminate grades:
 - a. Exposed doors, finished end panels, and other vertical surfaces: GP28 (0.028 inch thick nominal)
 - b. Horizontal surfaces other than top: GP28 (0.028 inch thick nominal)
 - c. Cabinet Liner: CL20 (0.020 inch nominal), white.
 - d. Work Surfaces and Countertops: GP50 (0.050 inch thick nominal) with BK20 (0.20 inch thick) backer sheet.
 - e. Backsplash: PH42 (0.042 inch nominal) with nominally balanced backer sheet.
 3. Adhesive: PVA water resistant adhesive. Contact adhesives not permitted.
 4. Pressure Fused Laminate:
 - a. NEMA LD3 VGL, and NEMA LD3 CLS, Melamine resin impregnated, 120 gram PSM minimum, thermofused to core under pressure.
 - b. Color:
 - 1) Closed interiors, underside of wall cabinets: White.
 - 2) Exposed and Semi-exposed open cabinets: Match exterior.
 - c. Provide balanced construction with same thermofused melamine. Unsurfaced coreboard or simple backers not allowed.
- B. Core Material:
1. Particleboard: ANSI 208.1, minimum 45 pcf density, Grade M-3.
 2. Plywood: Shop sanded, exterior grade veneer cored, hardwood faced, any species, with no defects affecting strength or utility. Overlay plywood not permitted. Plywood allowed at countertops and toe-base only.
 3. Water resistant treated plywood: shall have 24 hour thickness swell factor of five percent or less and 24 hour water absorption factor of ten percent or less; P.S. 51, Type II or better.
 4. Cabinet components shall be of the following minimum core thicknesses:
 - a. Cabinet backs, drawer body, and drawer bottoms: 1/2 inch particleboard
 - b. Door and drawer face, base, wall, and tall cabinet tops and bottoms, cabinet sides, drawer spreaders, cabinet back rear hangstrips, structural dividers, and exposed cabinet backs: 3/4 inch particleboard
 - c. Work surfaces and countertops: minimum 1 inch particleboard or plywood, except use water resistant treated plywood core at counters with sinks.
 - d. Shelves: 3/4 inch particleboard core for 30 inches long or less, 1 inch thick particleboard core for more than 30 inches long; 14 inch deep, unless otherwise noted. Provide vertical dividers for shelves over 36 inches long.
 - e. Cabinet Toe-Base: 3/4 inch plywood. No particleboard within four (4) inches of floor.
- C. Countertops and Backsplashes:

1. Countertops: Provide countertops with PVC edge in as long as practical continuous lengths. Provide field glued splines at joints. No joints closer than 24 inches either side of sink cutout.
 2. Backsplash: Integral to countertop, 4 inch high unless otherwise shown. Fabricate with single continuous sheet of laminate from front counter to top of splash with no joints from horizontal to vertical application. No joints shall occur at sink openings.
 3. At exposed countertop end corners, provide 1 inch radius, or similar safety treatment.
- D. Toe Spaces: Leave toe spaces unfinished for installation of resilient base, unless otherwise shown.
- E. End Panels and Filler Strips: Match adjacent case-piece.
- F. Edging:
1. Provide the following in accordance with "Edging Locations":
 - a. Flat Edge PVC: 0.020 inch. Solid, high-impact, purified, color-thru, acid resistant, machine-applied with hot melt adhesives.
 - b. 3 mm PVC: Solid, high-impact, purified, color-thru, acid resistant, pre-lamination primed edging, machine-applied with hot melt adhesives, and machine profiled to 1/8 inch radius.
 2. Edging Locations:
 - a. Cabinet body edge, including door/drawer front spacer rail: Flat Edge PVC, color matched to door/drawer face or as selected.
 - b. Forward edge of interior body components, interior dividers, shelf, and top edges of drawer body: Flat Edge PVC to match cabinet interior surface color.
 - c. Door/Drawer-Front edging: 3mm PVC, color matched to standard laminates.

2.3 CABINET HARDWARE

- A. All hardware shall meet ANSI A156.9 and shall be subject to approval by the Architect. All keying shall match existing master key system and be approved by the Owner.
1. Acceptable Manufacturers:
 - a. Accuride
 - b. National
 - c. Knappe & Vogt
 - d. Ives
 - e. Stanley
 - f. As specified herein, provide specified product, or Architect approved equal.
- B. Hinges:
1. Heavy duty, five-knuckle 2 3/4 inch institutional type hinge shall meet ANSI/BHMA A156.9 Grade 1 requirements. Mill ground, hospital tip, Teflon coated tight pin feature with all edges eased. Hinge shall be full wrap around type of tempered steel 0.095 inch thick. Each hinge shall have minimum of 9 screws, #7, 5/8 inch FHMS to assure positive door attachment.
 2. One pair per door to 48 inch height. One and one-half pair over 48 inches in height. Hinge shall accommodate 13/16 thick laminated door and allow 270 degree swing.
 3. Finish: US26D.
- C. Pulls:
1. Wire design, 4 inches, Chrome, US26D finish.

- D. Sliding Door Hardware:
 - 1. Frameless 1/4 inch glass sliding doors: double track rolling door assembly.
 - 2. Framed 13/16 inch thick stile and rail sliding doors: top mounted track with dual roller hangers. Vertical adjustment for accurate alignment.
- E. Drawer Slides:
 - 1. Standard Drawers: 3/4 extension, self-closing, white epoxy-coated, lever disconnect, positive in-stop/out-stop, nylon rollers, minimum 100 pound dynamic load rating at full extension.
 - 2. File Drawers: Full extension, 3-part progressive opening slide, precision steel ball bearing, minimum 100 pound dynamic load rating at full extension, zinc plated or epoxy coated at manufacturer's option.
 - 3. Provide body mounted molded rails for hanging file system for legal or letter size as indicated by manufacturer's model number. Cutting or machining of drawer body/face not permitted.
 - 4. Paper Storage Drawers: Full extension, self-closing, white epoxy-coated, lever disconnect, positive in-stop/out-stop, nylon rollers, minimum 150 pound dynamic load rating at full extension.
- F. Catches: Provide opening resistance in compliance with the Americans with Disabilities Act.
 - 1. Provide top-mounted magnetic catch for base and wall cabinet door.
 - 2. Provide two at each tall cabinet door. Catch housing shall be molded in White.
- G. Adjustable Shelf Supports:
 - 1. Dual-pin design with anti tip-up shelf restraints for both 3/4 inch and 1 inch shelves.
 - 2. Include keel to retard shelf slide-off, and slot for mechanical attachment of shelf to clip.
 - 3. Load rating shall be minimum 300 pounds each support without failure.
- H. Wardrobe Rod: 1-1/6 inch diameter plated steel rod, with captive sockets.
- I. Coat Hooks: Single and double prong, wall mount - Satin Aluminum.
- J. Locks: Five-disk tumbler cam-style with strike. Locks on cabinets in same room keyed alike. Provide two (2) keys per room where doors and drawers are scheduled to receive locks. Dull chrome finish. Lock core shall be removable with a control key, permitting Owner to change lock arrangements without tools.

2.4 SPECIALTY ITEMS

- A. Grommets:
 - 1. Size: 2-1/2 inches diameter with "Flip-Top"™ tab in cap.
 - 2. Colors: As selected by Architect from manufacturer's available colors.
 - 3. Number/Location: Where electrical, telephone, and computer data wiring need to pass through tops whether shown or not.
 - 4. Approved Product/Manufacturer: Model No. EDP3 manufactured by Doug Mockett & Company, Inc., Manhattan Beach, CA; (800) 523-1269, or Architect approved equal.
- B. Keyboard Drawers (At all knee spaces):
 - 1. Approved Product/Manufacturer: No. SD-1 as manufactured by Knappe & Vogt; or Architect approved equal.

- C. Molded Personal Pencil Drawer: High-impact 100 Polystyrene with in-stop, out-stop, and self-closing features. Provide under top mounted 100 lb self-closing slides. Twelve compartment drawer body, and slides, Black. Provide where indicated on plans.
- D. Mailbox Label Holder: Brass, card size 1/2" x 2-3/16". Provide one (1) at each opening.

2.5 SOLID STOCK

- A. Moisture Content: Percent of moisture in relation to over-dry weight shall be between 8 percent and 13 percent at time of installation.
- B. Natural Finish Hardwood:
 - 1. Occasional knot permitted provided it is tight and smooth.
 - 2. Grain Pattern: Rift-cut
 - 3. Species: AWI "Premium" Grade, White Oak
- C. Paint Grade Hardwood: Any species, including Parana Pine, except do not use Oak, Elm or similar species which have coarse grain.

2.6 MISCELLANEOUS

- A. Utility Shelving: AWI "Economy" grade.
- B. Clothes Rod: 1-1/2 inch diameter smooth wooden dowel by length required, with end supports and fasteners of type recommended to suit application.
- C. Telephone/MDF/IDF Board: Provide minimum 4 foot by 8 foot by 3/4 inch thick plywood for telephone/data punch down blocks and video equipment in accordance with Section 06 10 00, Rough Carpentry. Paint in accordance with Section 09 91 00, Painting.

2.7 BALLET BARS

- A. Type: Stationary Wall Mounted Ballet Bars
- B. Construction:
 - 1. Material: 1-1/2 inch diameter by length shown on drawings, hand sanded Red Oak rail. The bar shall be cut at the center to allow for shipment.
 - 2. Color/Finish: Match approved Architect's sample from manufacturer's standard colors and finishes.
 - 3. Attachment: Shall be to wall with three (3) plated mounting brackets for each 12'-0" of bar. Provide all anchors and fasteners of type instructed by manufacturer to suit installation on required wall types.

2.8 MILLWORK FABRICATION

- A. Fabricate casework, countertops and related products to dimensions, profiles and details shown on drawings. Fabricate casework square, plumb, and true.
- B. Detailed Requirements For Cabinet Construction:
 - 1. Toe-Base:
 - a. Continuous, ladder type platform with concealed fastening to cabinet bottom, level and secured to floor
 - b. Toe-base at exposed cabinet end panels shall be recessed 1/4 inch from face of finished end, for flush installation of finished base material.
 - c. No cabinet sides-to-floor will be allowed.

2. Cabinet Top and Bottom:
 - a. Solid sub-top shall be furnished for all base and tall cabinets.
 - b. At cabinets over 36 inches bottoms and tops shall be mechanically joined by a fixed divider.
 - c. Assembly devices shall be concealed on bottom side of wall cabinets.
3. Cabinet Sides:
 - a. Doweled, and glued under pressure, or attached with fully concealed interlocking mechanical fasteners to sub-top and bottom.
 - b. Drill holes for adjustable shelves 1-1/4 inches on center.
4. Cabinet Backs:
 - a. Side bound, captured in grooves, recessed from cabinet rear, and securely fastened at top and bottom.
 - b. Hang rails shall be located at rear of cabinet back and fastened to cabinet sides. Provide minimum of two (2) at base, two (2) at wall, and three (3) at tall cabinets as instructed by casework manufacturer.
 - c. Provide removable back panels and closure panels for plumbing access at all sink cabinets, and where shown on drawings.
5. Exposed end corner and face frame attachment:
 - a. Butt joint, glued and finish nailed; or attached with fully concealed interlocked mechanical fasteners.
6. Door and Drawer Fronts:
 - a. Drawer fronts and hinged doors shall overlay the cabinet body. Maintain a maximum 1/8 inch reveal between pairs of doors, between door and drawer front, or between multiple drawer fronts within the cabinet.
 - b. Where indicated, provide Stile and Rail doors with full 1/4 inch plate glass, hinged or sliding. Exposed lite-opening edges shall be trimmed and glazed with extruded glazing bead.
 - c. Where indicated, frameless sliding glass doors shall be 1/4 inch thick plate glass with ground and polished edges. Fit with anodized aluminum shoes and nylon rollers.
- C. Drawers:
 1. Drawer fronts: apply to separate drawer body component sub-front.
 2. Drawer sides: doweled to receive front and back, glued under pressure, machine squared.
 3. Drawer bottom: set into front and sides, 1/4 inch deep groove with minimum 3/8 inch standing shoulder, continuously glued. Reinforce drawer bottoms with 1/2 inch by 4 inch front-to-back intermediate underbody stiffeners, mechanically fastened. One at 24 inches, two at 36 inches, and over.
 4. Paper storage drawers: fitted with full width hood at back.
 5. Hanging file drawers shall be fabricated to accept letter size hanging folders compatible with Pendaflex system.
- D. Vertical and Horizontal Dividers: As required by manufacturer for type and style of component.
- E. Door/Drawer Front Rail: As required by manufacturer for type and style of component, and hardware placement.
- F. ADA Accessible, Americans with Disabilities Act Requirements: The following special requirements shall be met, where specifically indicated on architectural plans as "ADA", or by General Note. Shall be in compliance with Federal Register Volume 56, No. 144, Rules and Regulations:

1. Countertop height: With or without cabinet below, not to exceed a height of 34 inches Above Finished Floor (A.F.F.), at a surface depth of 24 inches
2. Kneespace clearance: minimum 29 inches A.F.F. at apron, and 30 inches clear span width.
3. 12 inch deep shelving, adjustable or fixed: Not to exceed a range from 9 inches A.F.F. to 54 inches A.F.F.
4. Wardrobe cabinets: Provide with rod/shelf adjustable to 48 inches A.F.F. at a maximum 21 inch shelf depth.
5. Sink cabinet clearances: In addition to above, upper kneespace frontal depth shall be no less than 8 inches, and lower toe frontal depth shall be no less than 11 inches, at a point 9 inches A.F.F., and as further described in Volume 56, Section 4.19.

G. Typical Desk or Counter Height at Kneespace Locations: 30" above finished floor.

PART 3 - EXECUTION

3.1 MILLWORK INSTALLATION

- A. Positioning: Place approximately level, plumb and at right angles to adjacent work.
- B. Fitting: Where field cutting or trimming is necessary, perform in a neat, accurate, professional manner without damaging the products and adjacent work.
- C. Anchorage: Attach securely so the products will perform to their maximum ability without damage from inadequate fastenings.
- D. Fasten tops to frames with concealed clips, screws and glue.
- E. Install simulated wood trim in locations shown on drawings and in accordance with manufacturer's instructions.

3.2 EXISTING DOOR LAMINATE RESURFACING

- A. Resurfacing procedures shall be in accordance with the recommendations and instructions of the laminate and adhesive manufacturers.
- B. Acclimate laminate to the same environment as existing material at least 48 hours. Perform work in well ventilated area, out of the way of construction dust and traffic to maintain clean adhesion.
- C. Clean the substrate with detergent or non-flammable solvent as instructed by laminate manufacturer to remove wax, grease, and polish deposits.
- D. Using a belt sander or sander instructed by manufacturer, sand entire surface to remove original finish. Remove sanding dust thoroughly.
- E. Coat the sanded surface and back of laminate with a uniform coating of contact adhesive. Allow to dry thoroughly prior to assembling. Assembling wet adhesive lines will trap solvent and may result in poor bonding. Follow the adhesive manufacturer's instructions.
- F. Index the laminate with the substrate. Make initial contact by smoothing with palms. Apply pressure using a "J" roller or rotary press. Allow to set as instructed by adhesive manufacturer to achieve full adhesion to maintain warranty. Trim with recommended tools.

- G. Apply laminate to door faces, and exposed vertical edges. Apply edges before face. Paint top and bottom edges to color match facing.
- H. Coordinate hardware and vision lite cutouts with work of other sections.

3.3 FINISH HARDWARE INSTALLATION

- A. The supplier will mark each item of hardware for location. Protect the markings until each item is installed. If any item is delivered to the job not properly marked, return it to the supplier for marking before attempting to install it.
- B. Check markings on hardware for proper location. Install and make necessary adjustments for proper working order. Any hardware damaged by improper adjustment or careless abuse will be replaced by the Contractor at his expense.
- C. Provide clean, properly sized and accurately placed mortises and drilled holes for all mortise hardware such as locksets and for cylindrical locks where specified only.
- D. Fit all surface-applied hardware accurately.
- E. After hardware is installed, protect exposed surfaces by use of heavy paper and masking tape and maintain until job completion.
- F. Remove all door hardware except that which is primed for painting before painter's finish is applied. Permanently replace and re-adjust for proper function after painter's finish has dried hard.
- G. Millwork contractor shall be responsible for hardware on millwork.

3.4 PLASTIC LAMINATE FACED WOOD DOOR INSTALLATION

- A. Protect all doors during handling.
- B. Refer to Section 08 71 00, Door Hardware for hardware requirements.
- C. Install doors in accordance with manufacturer's instructions.
- D. Install and adjust doors for smooth, quite operation.

END OF SECTION 06 20 00

SECTION 07 13 00 - SHOWER STALL WATERPROOFING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Shower stall waterproofing installed at floors of all showers.

1.3 DEFINITIONS

- A. Comparable Product: Product demonstrated and approved through submittal process, or where indicated as a produce substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.4 REFERENCES

- A. ASTM International (ASTM)
 - 1. D4068, Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane

1.5 RESPONSIBILITY OF COORDINATION

- A. Coordinate the work specified with the following work:
 - 1. Concrete work
 - 2. Plumbing work
 - 3. Gypsum wallboard work

1.6 SUBMITTALS

- A. Product Data: Submit literature and illustrations to indicate the performance and fabrication procedures.
- B. Samples: Submit 12 inch by 12 inch samples for final approval.

1.7 DELIVERY AND STORAGE

- A. Delivery: Deliver clearly labeled, undamaged materials in the manufacturer's unopened containers.
- B. Timing and Coordination: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. Storage: Store materials in a clean, dry location, protected from weather and abuse.

1.8 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 00 – Project Management and Coordination.

1.9 WARRANTY

- A. Warrant the work specified herein for the life of the original installation against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Deterioration
 - 2. Leaking
 - 3. Releasing from substrate

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufactures listed whose products meet or exceed the specifications are approved for use on the project. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions to be considered.
 - 1. Chloraloy 240 CPE Shower Pan Liner manufactured by The Noble Company; (800) 878-5788 or comparable product.

2.2 MATERIALS

- A. Shower Pan:
 - 1. Type: Chlorinated polyethylene (CPE) waterproofing/cleavage membrane for full mortar bed ceramic tile installations at shower pans and shower floor waterproofing and drain systems.
 - 2. Thickness: 0.040 inch nominal.
 - 3. Weight: Approximately 60 lbs. per roll.
 - 4. Coverage: 200 square feet per roll.
 - 5. Roll Sizes: 60 inches wide x 40 feet long and 48 inches wide x 50 feet long.
- B. Adhesive and Accessories: Type recommended by manufacturer to suit application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locations: Install membrane in accordance with manufacturer's instructions under shower stall floors and around perimeter of shower area, up walls and over curbs, where indicated.
- B. Coordinate work with Section 03 30 00, Cast-In-Place Concrete and Section 09 21 16, Gypsum Wallboard Systems.
- C. Adjacent work: Protect work by masking, covering, or other precautionary methods. Remove protection when no longer necessary.
- D. Lengths: Install membrane with minimum number of joints within the shower floor. If membrane is not available in a single width, join by lapping membrane minimum two (2) inches and seal joint throughout its length in accordance with manufacturer's instructions.
- E. Penetrations: Where drain penetrates membrane, make opening snug and seal in accordance with manufacturer's instructions.

END OF SECTION 07 13 00

SECTION 07 19 00 - WATER REPELLENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Penetrating water repellent treatment for masonry and concrete surfaces.
 - 2. Film forming water repellent treatments for masonry and concrete surfaces.
 - 3. Accessories necessary for a complete installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Performance: Water repellents shall meet the following performance requirements as determined by testing on standard substrates representing those indicated.
- B. Water Absorption: Minimum 90 percent reduction of water absorption after 24 hours for treated compared to untreated specimens when tested according to the following:
 - 1. Cast Stone: ASTM C 1195.
 - 2. Concrete Masonry Units: ASTM C 140.
 - 3. Clay Brick: ASTM C 67.
 - 4. Portland Cement Plaster (Stucco): ASTM D 6532.
- C. Water-Vapor Transmission: Comply with one or both of the following:
 - 1. Maximum 10 percent reduction water-vapor transmission of treated compared to untreated specimens, according to ASTM E 96/E 96M.
 - 2. Minimum 80 percent water-vapor transmission of treated compared to untreated specimens, according to ASTM D 1653.
- D. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate of treated compared to untreated specimens, according to ASTM E 514/E 514M.
- E. Durability: Maximum 5 percent loss of water repellent performance after 2500 hours of weathering according to ASTM G 154 compared to water repellent-treated specimens before weathering.

1.4 SUBMITTALS

- A. Product Data: Technical data including include performance data, DFT per coat, spreading rate, number of coats for each type of substrate, application procedures, and available colors.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.
- B. Preinstallation Conference: Conduct conference at site.

1.6 PROJECT CONDITIONS

- A. Limitations: Proceed with application when existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than 28 days.
2. Building has been closed in for not less than 30 days before treating wall assemblies.
3. Ambient temperature is above 40 degrees F (4.4 degrees C) and below 100 degrees F (37.8 degrees C) and will remain so for 24 hours.
4. Substrate is not frozen and substrate surface temperature is above 40 degrees F (4.4 degrees C) and below 100 degrees F (37.8 degrees C).
5. Rain or snow is not predicted within 24 hours.
6. Not less than 24 hours have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.7 WARRANTY

- A. Warranty: Written warranty signed by manufacturer in which manufacturer **and applicator** agree to repair or replace materials that fail to maintain water repellency within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENTS

- A. Silane, Penetrating Water Repellent: Clear, containing **20** percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water, or other proprietary solvent carrier; and with 400 g/L or less of VOCs.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. W.R. Meadows; (800) 342-5976.
 - b. Advanced Chemical Technologies, Inc.; (405) 843-2585.
 - c. BASF Corporation; Construction Systems; (800) 526-1072.
 - d. Dayton Superior; (281) 590-6670.
 - e. Euclid Chemical Company (The); an RPM company; (800) 321-7628.
 - f. PROSOCO, Inc.; (800) 255-4255.
 - g. Tnemec, Inc.; (816) 483-3400.
 - h. Vexcon Chemicals Inc.; (888) 839-2661.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements and conditions affecting performance of the Work.
 1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in minimum of three representative locations by method recommended by manufacturer.
 2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
 3. Verify that required repairs are complete, cured, and dry before applying water repellent.
- B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica containing or siliceous minerals.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. New Construction and Repairs: Allow concrete and other cementitious materials to age before application of water repellent, according to repellent manufacturer's written instructions.
- B. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water repellent manufacturer's written instructions:
 - 1. Cast Stone and Concrete Unit Masonry: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents according to ASTM E 1857.
 - 2. Clay Brick Masonry: ASTM D 5703.
 - 3. Natural Stone: ASTM C 1515.
 - 4. Portland Cement Plaster (Stucco): ASTM E 1857.
- C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.
- D. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.
- E. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.
 - 1. Water repellent work may precede sealant application if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.3 APPLICATION

- A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.
- B. Apply coating of water repellent on surfaces to be treated using 15 psi (103 kPa) pressure spray with a fan type spray nozzle, roller, or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
 - 1. Precast Concrete and Cast Stone: At Contractor's option, first application of water repellent may be completed before installing units. Mask mortar and sealant bond surfaces to prevent water repellent from migrating onto joint surfaces. Remove masking after repellent has cured.
- C. Apply second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.4 FIELD QUALITY CONTROL

- A. Testing of Water Repellent Material: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when water repellent is being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample water repellent material being used. Samples of material delivered to site will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
 3. Owner may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor shall remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Architect.
- B. Coverage Test: In the presence of Architect, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.
1. Notify Architect **seven** days in advance of the dates and times when surfaces will be tested.
 2. Reapply water repellent until coverage test indicates complete coverage.

3.5 CLEANING

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Architect.
- B. Comply with manufacturer's written cleaning instructions.

END OF SECTION 07 19 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Polyisocyanurate foam plastic board.
 - 2. Thermal insulation.
 - 3. Accessories necessary for a complete installation.

1.3 DEFINITIONS

- A. Comparable Product: Product demonstrated and approved through submittal process, or where indicated as a produce substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.4 RELATED SECTIONS

- A. Section 04 20 00 - Unit Masonry.
- B. Section 07 81 00 - Applied Fireproofing.
- C. Section 07 84 00 – Firestopping.
- D. Section 07 84 13 – Penetration Firestopping.
- E. Section 09 21 16 - Gypsum Board Assemblies.
- F. Section 09 51 00 - Acoustical Ceiling Panels.
- G. Division 23 – Mechanical: Duct Insulation.

1.5 SUBMITTALS

- A. Product Data: Technical data and installation instructions for each type of insulation product specified.
- B. Samples: Six (6) inch x six (6) inch piece of rigid insulation for Architect's approval.
- C. Certifications:
 - 1. Manufacturer's certification of compatibility of rigid insulation with dampproofing mastic.
 - 2. Manufacturers affidavit that materials used in Project contain no asbestos.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. Fire Performance Characteristics: Identify products with appropriate markings of applicable testing and inspecting organization.
 - a. Surface Burning Characteristic: ASTM E 84.
 - 1) Flame Spread Index: Maximum 25.
 - 2) Smoke Developed Index: Maximum 450.
 - b. Fire Resistance Ratings: ASTM E 119.
 - c. Combustion Characteristics: ASTM E 136.
 2. National Fire Prevention Association (NFPA) 255 Test of Surface Burning Characteristics of Building Materials.
 3. Underwriter's Laboratories (UL) 723 Tests for Surface Burning Characteristics of Building Materials.
- B. Cellulose Insulation Manufacturer: Manufacturer having minimum 5 years documented experience and ISO 9002 Certified.
1. Manufacturer shall provide independent laboratory follow up inspection services of Underwriters Laboratory and Factory Mutual. Label each bag accordingly.
- C. Cellulose Insulation Applicator: Applicator having minimum 5 years documented experience and licensed by manufacturer.
- D. Single Source Responsibility for Insulation Products: Obtain each type of building insulation from single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of Work.
- E. Environmental Requirements: Manufacture extruded polystyrene with HCFC or other CFC free blowing agents. Mark insulation boards and packages with manufacturer's name and product designation. Unmarked boards and packages will be rejected.
1. Wherever possible, provide boards from manufacturers who recycle insulation materials.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam plastic board insulation:
1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

1.8 PROJECT CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.
- B. Sequence Work to ensure fireproofing and firestop materials are in place before beginning Work.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS/PRODUCTS

- A. Specifications are based on any of the manufacturers listed below, with their product in parenthesis for the particular insulation application. Other manufacturers not listed must have a minimum of five (5) years' experience manufacturing products meeting or exceeding the specifications and comply with Division 1 regarding substitutions to be considered.

2.2 POLYISOCYANURATE FOAM PLASTIC BOARD

- A. Polyisocyanurate Board, Foil Faced: ASTM C 1289, foil faced, Type I, Class 1 or 2.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atlas Roofing Corporation.
 - b. Hunter XCI
 - c. Dow Chemical Company (The).
 - d. Owens Corning.
 - e. Firestone Building Products.
 - f. Rmax, Inc.
 2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.3 THERMAL INSULATION

- A. Thermal Insulation, Unfaced: ASTM C 665, Type I. with maximum flame spread and smoke developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Guardian Building Products, Inc.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Knauf Insulation.
 - e. Owens Corning.
 2. Thickness/R- Values (minimum):
 - a. 3-1/2 inches/ R-11 where shown on the Drawings.
 - b. 6 inches/ R-19 where shown on the Drawings.

2.4 INSULATION FASTENERS

- A. Adhesively Attached, Spindle Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Plate: Perforated, galvanized carbon steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
 2. Spindle: Coppercoated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
- B. Adhesively Attached, Angle Shaped, Spindle Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
1. Angle: Formed from 0.030 inch (0.762 mm) thick, perforated, galvanized carbon steel sheet with each leg 2 inches (50 mm) square.

2. Spindle: Copper coated, low carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.
- C. Insulation Retaining Washers: Self-locking washers formed from 0.016 inch (0.41 mm) thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
 1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Crawl spaces.
 - b. Ceiling plenums.
 - c. Attic spaces.
- D. Insulation Standoff: Spacer fabricated from galvanized mild steel sheet for fitting over spindle of insulation anchor to maintain air space of 2 inches (50 mm) between face of insulation and substrate to which anchor is attached.
- E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.5 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 1. Glass Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame spread and smoke developed indexes of 5, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
- C. Asphalt Coating for Cellular Glass Block Insulation: Cutback asphalt or asphalt emulsion of type recommended by manufacturer of cellular-glass block insulation.
- D. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.
- B. Foam in Place Insulation: Verify that substrates are clean, dry, and free of substances that are harmful to insulation.
 1. Priming: Prime substrates where recommended by insulation manufacturer. Apply primer to comply with insulation manufacturer's written instructions. Confine primers to areas to be insulated; do not allow spillage or migration onto adjoining surfaces.

3.2 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Board Insulation: Install insulation that is undamaged, dry, and unsoiled and has not been exposed to ice, rain, or snow at any time.

1. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
 2. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.
- C. Batt Insulation (Thermal and Sound): Walls: Insulation shall be friction fit between studs and provide full coverage where indicated on Drawings. Insulation shall be tight within spaces in partitions, around cut openings, behind and around electrical and mechanical items within or behind partitions and tight to items passing through partitions. Wall areas above ceiling: At side wall insulation in ceiling cavity, install adhesive-mounted impaling devices with metal caps at 2 feet-0 inches vertically and at four (4) inches from each side of blankets horizontally. Install blankets with four (4) foot dimension running vertically on spikes, keeping blankets tight to exterior wall without crushing into each other.
- D. Framed Construction: Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. Attics: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
 5. For metal framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 6. For wood framed construction, install blankets according to ASTM C 1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
 7. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - a. Glass Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
- E. Curtain Wall: Install board insulation in curtain wall construction according to curtain wall manufacturer's written instructions.
1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated on Drawings between insulation and glass.
 2. Install insulation to fit snugly without bowing.

3.3 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to

abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 27 26 - FLUID APPLIED AIR BARRIER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Fluid-applied air barrier membrane in exterior wall assemblies.
- B. Materials to bridge and seal the following air leakage pathways and gaps:
 - 1. Connections of the walls to the roof air barrier.
 - 2. Connections of the walls to the foundation air barrier.
 - 3. Seismic and expansion joints.
 - 4. Openings and penetrations of window frames, storefront, curtain wall and mechanical, electrical and plumbing systems.
 - 5. Barrier precast concrete and other envelope systems.
 - 6. Door frames.
 - 7. Piping, conduit, duct and similar penetrations.
 - 8. Masonry ties, screws, bolts and similar penetrations.
 - 9. All other air leakage pathways in the building envelope.
- C. Related Work in other Sections includes but is not limited to the following:
 - 1. Section 01 45 00 – Quality Control
 - 2. Section 01 50 00 – Temporary Facilities and Controls
 - 3. Section 04 20 00 – Unit Masonry
 - 4. Section 07 41 13 – Prefinished Metal Roofing
 - 5. Section 07 54 23 – Fully Adhered Thermoplastic Membrane Roofing System
 - 6. Section 07 65 00 – Flexible Flashing
 - 7. Section 07 90 00 – Joint Sealants

1.3 PERFORMANCE REQUIREMENTS

- A. Material Performance: Provide air barrier materials which have an air permeance not to exceed 0.004 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.004 cfm / ft² @ 1.57 psf), when tested in accordance with ASTM E2178 (unmodified).
- B. Provide materials with a water vapor permeance of 10.0 US perms or greater, determined in accordance with ASTM E96 Water method (Procedure B).
- C. Assembly Performance: Provide a continuous air barrier in the form of an assembly that has an air leakage not to exceed 0.04 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.04 cfm/ft² @ 1.57 psf) when tested in accordance with ASTM E2357. The assembly shall accommodate movements of building materials by providing expansion and control joints as required. Expansion / control joints, changes in substrate and perimeter conditions shall have appropriate accessory materials at such locations.
 - 1. The air barrier assembly shall be capable of withstanding combined design wind, fan and stack pressures, both positive and negative on the envelope without damage or displacement, and shall transfer the load to the structure.

2. Fluid applied air barriers shall not displace adjacent materials in the air barrier assembly under full load.
 3. The air barrier assembly shall be joined in an airtight and flexible manner to the air barrier materials of adjacent assemblies, allowing for the relative movement of assemblies due to thermal and moisture variations, creep, and anticipated seismic movement.
- D. Connections to Adjacent Materials: Provide connections to prevent air leakage at the following locations:
1. Foundation and walls, including penetrations, ties and anchors.
 2. Walls, windows, curtain walls, storefronts, louvers or doors.
 3. Different wall assemblies, and fixed openings within those assemblies.
 4. Wall and roof connections.
 5. Floors over unconditioned space.
 6. Walls, floor and roof across construction, control and expansion joints.
 7. Walls, floors and roof to utility, pipe and duct penetrations.
 8. Seismic and expansion joints.
 9. All other potential air leakage pathways in the building envelope.

1.4 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination

1.5 SUBMITTALS

- A. Submittals: Submit in accordance with Division 1 requirements.
- B. Installer Qualifications: Submit evidence of current Contractor accreditation and Installer certification under the Air Barrier Association of America's (ABAA). Submit accreditation number of the Contractor and certification number(s) of the ABAA Certified Installer(s).
- C. Product Data: Submit material Manufacturer's Product Data, material Manufacturer's instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions, Technical Data, and tested physical and performance properties.
1. Submit letter from primary air barrier material Manufacturer indicating approval of materials that are proposed to be used that are not currently listed in the accessories section of this specification for that Manufacturer's material.
 2. Include statement from the primary air barrier material Manufacturer that the materials used in their air barrier assembly which will be used to adhere to the underlying substrate are chemically compatible to the substrate material.
- D. Samples: Submit clearly labeled samples, three (3) inch by four (4) inch minimum size of each material specified.
- E. Shop Drawings of Mock-Up: Submit Shop Drawings of proposed mock-ups showing plans, elevations, large-scale details, and air barrier transitions and terminations.
- F. Field Test Results of Mock-Up: Submit test results of air leakage test and water leakage test of mock-up in accordance with specified standards, including retesting if initial results are not satisfactory.
- G. Shop Drawings: Submit Shop Drawings showing locations and extent of air barrier assemblies and details of all typical conditions, intersections with other envelope assemblies and materials, membrane counter-flashings, and details showing how gaps in the construction will be bridged, how inside and outside corners are negotiated, how materials that cover the materials are secured

with air-tight condition maintained, and how miscellaneous penetrations such as conduits, pipes, electric boxes and similar items are sealed.

1. Include VOC content of each material, and applicable legal limit in the jurisdiction of the project.
 2. Include statement that materials are compatible with adjacent materials proposed for use.
 3. Include required values for field adhesion test on each substrate in accordance with ASTM D4541 (modified), using a type II pull tester.
- H. Compatibility: Submit letter from primary material Manufacturer stating that materials proposed for use are permanently chemically compatible and adhesively compatible with adjacent materials proposed for use.

1.6 QUALITY ASSURANCE

- A. Air Barrier Installer Qualifications: Air barrier Subcontractor(s) shall be accredited at the time of bidding and during the complete installation period by the Air Barrier Association of America (ABAA).
1. Fluid-applied membrane air barrier Installer(s) shall be certified in accordance with the requirements outlined by ABAA. Installers shall have their photo identification air barrier certification cards in their possession and available on the project site, for inspection upon request.
- B. Manufacturer: Obtain primary ABAA Evaluated Materials from a single ABAA Evaluated Manufacturer regularly engaged in manufacturing specified fluid-applied membranes. Obtain secondary materials from a source acceptable to the primary materials Manufacturer.
- C. Accredited Laboratory Testing for Materials: Laboratory accredited by International Accreditation Service Inc. (IAS), American Association for Laboratory Accreditation (A2LA), or the Standards Council of Canada (SCC).
- D. VOC Regulations: Provide products which comply with applicable regulations controlling the use of volatile organic compounds.
- E. Preconstruction Meeting: Convene a minimum of two weeks prior to commencing Work of this Section. Agenda shall include, at a minimum, construction and testing of mock-up, sequence of construction, coordination with substrate preparation, air barrier materials approved for use, compatibility of materials, coordination with installation of adjacent and covering materials, and details of construction and chemical/fire safety plans. Attendance is required by the Fluid Applied Air Barrier System Manufacturer's field representative, representatives of related trades including covering materials, substrate materials and adjacent materials.
- F. Mock-Ups: Build mock-up representative of primary air barrier assemblies and glazing assemblies including backup wall and typical penetrations as acceptable to the Architect. Mock-up shall be dimensioned no less than eight (8) feet long by eight (8) feet high and include the air barrier materials and air barrier accessories proposed for use in the exterior wall assembly. The mock-ups shall remain visible and intact for the duration of the fluid applied air barrier system work scopes. Mock-ups shall be suitable for field testing.
- G. Mock-Up Tests for Air and Water Infiltration: The third party testing agency shall test the mock-up for air and water infiltration in accordance with ASTM E1186 (air leakage location), ASTM E783 (air leakage quantification) at a pressure differential of 1.57 lb/ft² (75 Pa) and ASTM E1105 (water penetration). Use smoke tracer to locate sources of air leakage. If deficiencies are found, the air barrier Contractor shall reconstruct mock-up at their cost for retesting until satisfactory results are obtained. Deficiencies include air leakage beyond values specified, uncontrolled water leakage, unsatisfactory workmanship.

1. Perform the air leakage test and water penetration test of mock-up prior to installation of cladding and trim but after installation of all fasteners for cladding and trim and after installation of other penetrating elements.

- H. Air Barrier Assembly Testing: Verify air barrier assembly testing by the material Manufacturer by visiting the ABAA website to ensure an ASTM E2357 test has been completed and to obtain results. Visit the ABAA website for the reported air barrier assembly leakage rate and illustrations or CAD details which includes the methods in which the assembly test mock-ups shall be assembled.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original packages with seals unbroken, labeled with material Manufacturer's name, product, date of manufacture, and directions for storage.
- B. Store materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by material Manufacturer. Protect stored materials from direct sunlight and other sources of ultra-violet light.
- C. Handle materials in accordance with Manufacturer's recommendations.

1.8 PROJECT CONDITIONS

- A. Temperature: Install fluid-applied air barrier material within range of ambient and substrate temperatures recommended by material Manufacturer. Do not apply air barrier to a damp or wet substrate.
- B. Field Conditions: Do not install air barrier in snow, rain, fog, or mist. Do not install air barrier when the temperature of substrate surfaces and surrounding air temperatures are below those recommended by the Manufacturer.
- C. Sequencing: Do not install air barrier material before the roof assembly has been sufficiently installed to prevent a buildup of water in the interior of the building.
- D. Compatibility: Do not allow air barrier materials to come in contact with chemically incompatible materials.
- E. Ultra-violet exposure: Do not expose air barrier materials to sunlight longer than as recommended by the material Manufacturer.

1.9 WARRANTY

- A. Material Warranty: Provide Manufacturer's standard product warranty, for a minimum 20 years from date of Substantial Completion.
- B. Subcontractor (approved by ABAA and Manufacturer) Installation Warranty: Provide a five (5) year installation warranty from date of Substantial Completion, including all accessories and materials of the air barrier assembly, against failures including loss of air tight seal, loss of watertight seal, loss of attachment, loss of adhesion and failure to cure properly.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fluid Applied Membrane Air Barrier: Use regular, high temperature or low-temperature formulation depending on site conditions, within temperature ranges specified by Manufacturer. Subject to compliance with requirements, provide one of the following:

1. BASF Corporation: MasterSeal AWB 660, Enershield HP, Finestop RA, Senershield R, Acrostop R and Sonowall FT R. Thickness for products are as specified by Manufacturer.
www.wallsystems.basf.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.0000 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0000 cfm/ft² @ 1.57 psf), at 10 mils (wet) when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 1004 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (1004 ng/(Pa·s·m²) / 17.6 US perms) at 10 mils (wet) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Fabric Reinforcement: Sheathing fabric to be saturated with BASF Fluid-Applied Membrane for use at sheathing joints, penetrations and window rough openings.
- 2) Flashing and Transition Membrane: WS Wrap polyester-faced 30-mil self-adhesive membrane or WS Membrane 20-mil self-adhesive membrane.
- 3) Water-based Primer for Self-Adhesive Membranes: WS Flashing Primer.
- 4) Mastics: As recommended by Manufacturer.

2. Carlisle Coatings and Waterproofing: Fire-Resist Barritech VP at 60 mils thick (wet).
www.carlisle-ccw.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.0002 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0002 cfm/ft² @ 1.57 psf), at 65 mils (wet), when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 817 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (817 ng/(Pa·s·m²) / 14.295 US perms) at 60 mils (wet) [40 mils (dry)] when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Detail Flashing: Fire-Resist 705 FR.
- 2) Counter-flashing for Metal Wall Flashings: Fire-Resist 705 FR.
- 3) Water-Based Primer for Detail Flashing: CCW-702 WB.
- 4) Solvent-Based Primer for Detail Flashing: CCW-702 or CCW-702 LV.
- 5) Solvent-Based Aerosol Primer for Detail Flashing: CAV-GRIP.
- 6) Reinforcing Fabric: DCH Reinforcing Fabric.

- 7) Glass Mat: LiquiFiber-W.
 - 8) Termination Mastic: SURE-SEAL Lap Sealant.
 - 9) Fill Compound: CCW-201 or CCW-703 V.
3. Dow Corning: DefendAir 200 at 15 mils thick (dry). www.buildabetterbarrier.com:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.0010 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0010 cfm/ft² @ 1.57 psf), [0.0049 liters per square meter per second under a pressure differential of 75 Pa (0.0049 L/(s·m²) @ 75 Pa)] at 15 mils (dry), when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 1387.7 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (1387.7 ng/(Pa·s·m²) [24.26 US perms] at 15 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Solvent-Based Primer: Dow Corning® DefendAir Primer
 - 2) Sealants: Dow Corning® 791 Silicone Weatherseal Sealant, Dow Corning® 756 SMS Silicone Sealant, Dow Corning® 795 Silicone Building Sealant, Dow Corning® 758 Silicone Weather Barrier Sealant
 - 3) Transition Membrane for details and terminations: Dow Corning® 778, Dow Corning® Silicone Transition Strip
 - 4) Flashing at Transition Membrane: Dow Corning® Silicone Transition Strip
 - 5) Counterflashing for Masonry Through-Wall Flashings: Dow Corning® Silicone Transition Strip
 - 6) Through-Wall Flashings or Shelf Angle Flashings: Dow Corning® 778
 - 7) Substrate Joint Treatment: Dow Corning® 791 Silicone Weatherseal Sealant
4. Dryvit Systems, Inc: Backstop NT at 12mils thick (dry). www.dryvit.com:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.000118 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.000118 cfm/ft² @ 1.57 psf), [0.0006 liters per square meter per second under a pressure differential of 75 Pa (0.0006 L/(s·m²) @ 75 Pa)] at 12 mils (dry), when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 1810 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (1810 ng/(Pa·s·m²) [31.65 US perms] at 20 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Transition Membrane for details and terminations: Dryvit AquaFlash and AquaFlash Mesh
 - 2) Reinforcing / Joint Tape: Dryvit Grid Tape
 - 3) Flashing at Transition Membrane: Dryvit AquaFlash
 - 4) Substrate Joint Treatment: Dryvit Grid Tape with Backstop NT

5. DuPont Building Innovations: Tyvek Fluid Applied WB at 25 mils thick (wet), 25 mils thick (dry). www.Weatherization.Tyvek.com:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.0002 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0002 cfm/ft² @ 1.57 psf), at 25 mils (dry), when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 1384 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (1384 ng/(Pa·s·m²) / 24.23 US perms) at 25 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Solvent Based Primer for Flashing, Transition Strip and Detail Membranes: 3M High Strength 90; Denso Butyl (used with self-adhered membranes only).
 - 2) Through-Wall Flashings or Shelf Angle Flashings: DuPont recommended through-wall flashing.
 - 3) Sealants, Mastics, Adhesives and Tapes: DuPont Sealant for Tyvek Fluid Applied System; DuPont Tyvek Flashing and Joint Compound; fiberglass mesh tape.
 - 4) Transition, Termination, and Detailing Membrane: DuPont StraightFlash, or DuPont Tyvek Flashing and Joint Compound (60mil).
 - 5) Penetrations and Termination Sealant: DuPont Sealant for Tyvek Fluid Applied System.
 - 6) Window Flashing Membrane: DuPont Tyvek Fluid Applied Flashing and Joint Compound, or DuPont Tyvek Fluid Applied Flashing – Brush Formulation, or DuPont StraightFlash with DuPont FlexWrap.
 - 7) Joint Treatment: None ($\leq 1/16$ " gaps); DuPont Tyvek Flashing and Joint Compound ($\leq 1/4$ " gaps); DuPont Tyvek Flashing and Joint Compound w/ fiberglass mesh tape ($\leq 1/2$ " gaps); DuPont StraightFlash (≤ 1 " gaps).
6. Grace Construction Products: Perm-A-Barrier VP, 90 mils thick (wet), 45 mils thick (dry). www.na.graceconstruction.com:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.0004 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0004 cfm/ft² @ 1.57 psf), at 69 mils (wet), when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 741.6 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (741.6 ng/(Pa·s·m²) / 12.9 US perms) at 40 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Membrane for details and Terminations: Bituthene Liquid Membrane.
 - 2) Water-Based Primer for Flashing, Transition Strip and Detail Membrane: Perm-A-Barrier WB Primer or Perm-A-Barrier Primer Plus.

- 3) Solvent-Based Primer for Flashing, Transition Strip and Detail Membrane: Bituthene Primer B-2 and Bituthene Primer B2 LVC or Bituthene Primer B2.
 - 4) Through-Wall Flashings or Shelf Angle Flashings: Perm-A-Barrier Wall Flashing.
 - 5) Sealants, Mastics, Adhesives and Tapes: As recommended by Grace Construction Products.
 - 6) Transition Membrane: Perm-A-Barrier Detail Membrane, Perm-A-Barrier Aluminum Flashing and Perm-A-Barrier Wall Flashing.
 - 7) Penetrations and Termination Sealant: Bituthene Liquid Membrane and as recommended by Grace Construction Products.
 - 8) Window Flashing and Detail Membrane: Perm-A-Barrier Detail Membrane, Perm-A-Barrier Aluminum Flashing and Perm-A-Barrier Wall Flashing.
 - 9) Joint Sealant: Refer to Technical Letter 1 for details on compatible waterproofing sealants.
7. Henry Company: Air Bloc 31 MR at 90 mils (wet). www.henry.com:
- a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.00024 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.00024 cfm/ft² @ 1.57 psf), at 87 mils (wet) when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 2066 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (2066 ng/(Pa·s·m²) / 36.12 US perms) at 44 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Transition Membrane: Blueskin SA and Blueskin SALT for low-temperature applications.
 - 2) Water-Based Primer for Transition Membrane: Aquatec Primer.
 - 3) Solvent-Based Primer for Transition Membrane: Blueskin Adhesive.
 - 4) Solvent-Based Aerosol Primer for Transition Membrane: Blueskin Spray Prep.
 - 5) Counter-flashing for Masonry Through-Wall Flashing: Blueskin TWF.
 - 6) Sealant: HE 925 BES Sealant.
 - 7) Reinforcing Tape: HE 183 Yellow Glass Fabric.
 - 8) Mastics, Adhesives and Tapes: Henry 570-05 Polybitume.
8. Momentive Performance Materials, Inc.: GE Elemax 2600 at 17 mils (dry). www.ge.com/silicones:
- a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.0006 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0006 cfm/ft² @ 1.57 psf), at 17 mils (dry) when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 581 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (581 ng/(Pa·s·m²) / 10.16 US perms) at 17 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Solvent-Based Primer: SS80.
- 2) Sealants: Elemax 5000 Liquid Flashing; SilPruf SCS2000; SilPruf SCS9000; SilPruf SCS2700; SWS.
- 3) Transition Membrane for details and terminations: Elemax 5000 Liquid Flashing; UltraSpan UST2200; UltraSpan USM pre-formed silicone molded corners parts.
- 4) Substrate Joint Treatment: Elemax 5000 Liquid Flashing; SilPruf SCS2000; SilPruf SCS9000; SilPruf SCS2700; SWS.
- 5) Reinforcing Fabric: RF100.

9. Pecora USA: Pecora XL-Perm ULTRA VP by Pecora USA at 9 – 12 mils (dry).
www.pecora.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.00024 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.00024 cfm/ft² @ 1.57 psf), 0.0012 liters per square meter per second under a pressure differential of 75 Pa (0.0012 L/(s·m²) @ 75 Pa] at 12 mils (dry) when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 727.01 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (727.01 ng/(Pa·s·m²) [12.71 US perms] at 9 mils - dry when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Sealants: 890NST Silicone Sealant, AVB Silicone Sealant
- 2) Transition Membrane for details and terminations: XL Span
- 3) Flashing at Transition Membranes: XL Flash Liquid Flashing & Joint Filler
- 4) Counter-Flashing for Masonry Through-Wall Flashings: XL Flash Liquid Flashing & Joint Filler
- 5) Through-Wall Flashings or Shelf Angle Flashings: XL Flash Liquid Flashing & Joint Filler
- 6) Substrate Joint Treatment: XL Flash Liquid Flashing & Joint Filler, 890 NST Silicone Sealant, AC-20 Latex Sealant, AVW-920 Latex Sealant, Dynatrol I-XL-345 Tru White STPU Sealant

10. PROSOCO, Inc.: Spray Wrap MVP at 10 mils (wet). www.prosoco.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.00086 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.00086 cfm/ft² @ 1.57 psf), when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 1430 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (1430 ng/(Pa·s·m²) / 25 US perms) at 10 mils (wet) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Water-Based Primer: PROSOCO R-GUARD PorousPrep for cut gyp board edged in rough openings.
- 2) Sealants: PROSOCO R-GUARD AirDam for interior perimeter seal in window installations.
- 3) Transition Membrane for details and terminations: PROSOCO R-GUARD SureSpan EX
- 4) Flashing at Transition Membrane: PROSOCO R-GUARD FastFlash
- 5) Counter-flashing for Masonry Through-Wall Flashings: PROSOCO R-GUARD Joint and Seam Filler followed by PROSOCO R-GUARD FastFlash.
- 6) Through-Wall Flashings or Shelf Angle Flashings: PROSOCO R-GUARD Joint and Seam Filler followed by PROSOCO R-GUARD FastFlash.
- 7) Substrate Joint Treatment: PROSOCO R-GUARD Joint & Seam Filler for sheathing seams, PROSOCO R-GUARD Joint & Seam Filler covered by PROSOCO R-GUARD FastFlash in rough opening.

11. PROSOCO, Inc.: Cat 5 at 12 - 15 mils (wet). www.prosoco.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.00018 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.00018 cfm/ft² @ 1.57 psf), when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 1015 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (1015 ng/(Pa·s·m²) / 17.71 US perms) at 12 – 15 mils (wet) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Water-Based Primer: PROSOCO R-GUARD GypPrime for cut gyp board edged in rough openings.
- 2) Sealants: PROSOCO R-GUARD AirDam for interior perimeter seal in window installations.
- 3) Counter-flashing for Masonry Through-Wall Flashings: PROSOCO R-GUARD Joint and Seam Filler followed by PROSOCO R-GUARD FastFlash.
- 4) Through-Wall Flashings or Shelf Angle Flashings: PROSOCO R-GUARD Joint and Seam Filler followed by PROSOCO R-GUARD FastFlash.
- 5) Substrate Joint Treatment: PROSOCO R-GUARD Joint & Seam Filler for sheathing seams, PROSOCO R-GUARD Joint & Seam Filler covered by PROSOCO R-GUARD FastFlash in rough opening.

12. Protecto Wrap: Protecto Wall Liquid Air Barrier VP by at 10 mils (dry). www.protectowrap.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.00086 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.000864 cfm/ft² @ 1.57 psf), 0.0043 liters per square meter per second under a pressure differential of 75 Pa (0.0043 L/(s·m²) @ 75 Pa)] at 10 mils (dry) when tested in accordance with ASTM E2178 (unmodified).

- 2) Water vapor permeance for this material has been tested and reported as being 660.8 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($660.8 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$) [11.5 US perms] at 22 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Water-Based Primer: Universal Water Based Primer.
- 2) Solvent-Based Primer: BT Primer.
- 3) Solvent-Based Aerosol Primer: Protecto-Tak Spray Adhesive.
- 4) Sealants: Protecto Wall Board to Board Joint Sealant.
- 5) Transition Membrane for details and terminations: Protecto Wall Transition Tape.
- 6) Solvent-Based Primer for Flashing, Transition Strip and Detail Membrane: BT Primer.
- 7) Water-Based Primer for Flashing, Transition Strip and Detail Membrane: Universal Water Based Primer.
- 8) Substrate Joint Treatment: Protecto Wall Board to Board Joint Sealant.

13. Sika Corporation: Sikagard 530 Liquid Applied Vapor Permeable Air Barrier at 30 mils (dry). www.sika.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being < 0.0001 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot ($< 0.0001 \text{ cfm}/\text{ft}^2 @ 1.57 \text{ psf}$), at 20 mils (dry) when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 661 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($661 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ / 11.5 US perms) at 22 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Water-Based Primer: Sikagard 530.
- 2) Solvent-Based Primer: Sikagard 510.
- 3) Termination Mastic: Sikaflex 11FC.
- 4) Sealants: Sikaflex 11FC.
- 5) Transition Membrane for details and terminations: SikaMultiSeal 515.
- 6) Reinforcing/Joint Tape: SikaMultiSeal 515.
- 7) Counterflashing for Masonry Through-Wall Flashings: SikaMultiSeal Plus.
- 8) Through-Wall Flashings or Shelf Angle Flashings: SikaMultiSeal Plus.
- 9) Substrate Joint Treatment: Sikaflex 11FC.

14. Soprema: Sopraseal LM 202 VP at 10 mils (wet) www.soprema.us

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.00004 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot ($0.00004 \text{ cfm}/\text{ft}^2 @ 1.57 \text{ psf}$), [0.0002 liters per square meter per second under a pressure differential of 75 Pa ($0.0002 \text{ L}/(\text{s}\cdot\text{m}^2) @ 75 \text{ Pa}$)] at 10 mils (wet) when tested in accordance with ASTM E 2178 (unmodified).

- 2) Water vapor permeance for this material has been tested and reported as being 1004 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($1004 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$) [17.6 US perms] at 10 mils (wet) when tested in accordance with ASTM E96 (water method – unmodified).
- b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Water Based Primer: Soprema Elastocol Stick H20 Primer
 - 2) Solvent-Based Primer: Soprema Sopraseal Stick primer
 - 3) Sealants: Soprema Sopraseal sealant
 - 4) Transition Membrane for details and terminations: Soprema Sopraseal Stick 1100T or Soprema Soprsolin HD
 - 5) Substrate Joint Treatment: Soprema Sopraseal Mesh
15. Sto Corp: Emerald Coat at 20 mils (dry). www.stocorp.com:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.000024 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot ($0.00024 \text{ cfm}/\text{ft}^2 @ 1.57 \text{ psf}$), [$0.00020 \text{ liters per square meter per second under a pressure differential of } 75 \text{ Pa}$ ($0.00020 \text{ L}/(\text{s}\cdot\text{m}^2) @ 75 \text{ Pa}$)] at 20 mils (dry) when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 797.94 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($797.94 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$) [13.95 US perms] at 12 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).
 - b. AIR BARRIER ACCESSORY MATERIALS:
 - 1) Joint and Rough Opening Treatments: Sto Gold Fill with StoGuard Mesh, StoGuard Rapid Seal with StoGuard Mesh, Sto EmeraldCoat with SToGuard Fabric, StoGuard Tape
 - 2) Joint Reinforcements: StoGuard Mesh, StoGuard Fabric, StoGuard RediCorner
 - 3) Transition Membranes: Sto Gold Fill with StoGuard Mesh, StoGuard RapidSeal or StoGuard RapidSeal with StoGuard Mesh, Sto Emerald Cost with StoGuard Fabric, StoGuard Tape
 - 4) Water-Based Primer for use with Flashing Transition: StoGuard
16. STS Coatings: Wall Guardian FW-100-A (Acrylic-based component) 40 mils (wet), 20 mils (dry). www.wallguardian.com:
 - a. AIR BARRIER MATERIAL PROPERTIES:
 - 1) Air permeance for this material has been tested and reported as being 0.0001 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot ($0.0001 \text{ cfm}/\text{ft}^2 @ 1.57 \text{ psf}$), at 20 mils (dry) when tested in accordance with ASTM E2178 (unmodified).
 - 2) Water vapor permeance for this material has been tested and reported as being 661 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($661 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2) / 11.5 \text{ US perms}$) at 22 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Water-Based Primer for Flashing, Transition Strip and Detail Membrane: None.
- 2) Solvent-Based Primer for Flashing, Transition Strip and Detail Membrane: BP-40 Primer for use with UT-40 Universal Tape.
- 3) Through-Wall Flashings or Shelf Angle Flashings: Gorilla Flash VF-1000.
- 4) Mastics: None.
- 5) Adhesives and Tapes: Universal Tape UT-40, a butyl based tape and Great Seal LT-100, a low voc elastomeric sealant for deflection joints and details.
- 6) Transition Strip: Universal Tape, UT-40.
- 7) Termination Mastic: Great Seal LT-100.
- 8) Window Flashing and Detail Membrane: Universal Tape UT-40.

17. TK Products: TK-AirMax 2103 at 40+ mils (wet). www.tkproducts.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.00097 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.00097 cfm/ft² @ 1.57 psf), 0.00492 liters per square meter per second under a pressure differential of 75 Pa (0.00492 L/(s·m²) @ 75 Pa)] at 40 mils (wet) when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 857 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (857 ng/(Pa·s·m²) [15.0 US perms] at 20 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Through-Wall Flashings or Shelf Angle Flashings: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18
- 2) Caulk: TK-Super Seal
- 3) Adhesives and Tapes: TK-AirMax 2200 All Weather Flashing (TK Products), TK Air Max 2203 Caulk, TK-AirMax 2201 Red Sheathing Facing Tape (Venture Tape, a 3M Company), 3M All-Weather Flashing Tape 8067 (3M Company), VentureStop VB 400 (Venture Tape, a 3M Company), Venture-1585 CW-2 Red Sheathing Facing Tape (Venture Tape, a 3M Company)
- 4) Transition Membranes: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18
- 5) Reinforcing / Joint Tape: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18
- 6) Termination of Caulk: TK-AirMax Caulk 2203 (TK Products), Manus-Bond 75AM (Manus Products, Inc.)
- 7) Flashing (Counter) for Masonry at Through-Wall Flashings or Transition Membranes: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18

18. TK Products: TK-AirMax 2104 at 40+ mils (wet). www.tkproducts.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.0008 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.0008 cfm/ft² @ 1.57 psf), at 40+ mils (wet) when tested in accordance with ASTM E2178 (unmodified).

- 2) Water vapor permeance for this material has been tested and reported as being 1007 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($1007 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ / 17.6 US perms) at 14 mils (dry) when tested in accordance with ASTM E96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Through-Wall Flashings or Shelf Angle Flashings: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18.
- 2) Caulk: TK-Super Seal.
- 3) Adhesives and Tapes: TK-AirMax 2200 All Weather Flashing (TK Products), TK Air Max 2203 Caulk, TK-AirMax 2201 Red Sheathing Facing Tape (Venture Tape, a 3M Company), 3M All-Weather Flashing Tape 8067 (3M Company), VentureStop VB 400 (Venture Tape, a 3M Company), Venture-1585 CW-2 Red Sheathing Facing Tape (Venture Tape, a 3M Company).
- 4) Transition Membranes: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18.
- 5) Reinforcing / Joint Tape: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18.
- 6) Termination of Caulk: TK-AirMax Caulk 2203 (TK Products), Manus-Bond 75AM (Manus Products, Inc.)
- 7) Flashing (Counter) for Masonry at Through-Wall Flashings or Transition Membranes: TK-Climate Flash, TK-Butyl Bond, TK-SS Flashing, TK-TWF-18.

19. Tremco, Inc.: ExoAir 230 at 40 mils (wet) www.tremcosealants.com

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.0003 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot ($0.0003 \text{ cfm}/\text{ft}^2 @ 1.57 \text{ psf}$), at 40 mils (wet) when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 1677 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential ($1677 \text{ ng}/(\text{Pa}\cdot\text{s}\cdot\text{m}^2)$ at 29 mils (dry) when tested in accordance with ASTM E 96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Solvent Based Primer: ExoAir Primer
- 2) Termination Mastic: ExoAir Termination Mastic
- 3) Sealants: Tremflex 834, Dymonic 100, Spectrem 1
- 4) Transition Membrane for Details and Terminations: ExoAir 110, ExoAir 111, ExoAir TWF, Dymonic 100
- 5) Reinforcing / Joint Tape: Tremco 2011 mesh
- 6) Flashing at Transition Membrane: ExoAir 111, ExoAir TWF, Dymonic 100
- 7) Counterflashing for Masonry Through Wall Flashings: ExoAir TWF
- 8) Through Wall Flashings or Shelf Angle Flashings: ExoAir TWF
- 9) Solvent Based Primer for Flashing, Transition Strip and Detail Membrane: ExoAir Primer
- 10) Substrate Joint Treatment: Tremflex 834, Dymonic 100 depending on substrate.

20. W.R. Meadows, Inc.: Air-Shield LMP, at 60 mils (wet), 30 mils (dry).
www.wrmeadows.com:

a. AIR BARRIER MATERIAL PROPERTIES:

- 1) Air permeance for this material has been tested and reported as being 0.000096 cubic feet per minute per square foot under a pressure differential of 1.57 pounds per square foot (0.000096 cfm/ft² @ 1.57 psf), [0.00048 liters per square meter per second under a pressure differential of 75 Pa (0.00048 L/(s·m²) @ 75 Pa)] at 20 mils (dry) when tested in accordance with ASTM E2178 (unmodified).
- 2) Water vapor permeance for this material has been tested and reported as being 598 nanograms of water vapor passing through each square meter of area per second for each Pascal of vapor pressure differential (598 ng/(Pa·s·m²) [10.47 US perms] at 30 mils (dry) when tested in accordance with ASTM E 96 (water method – unmodified).

b. AIR BARRIER ACCESSORY MATERIALS:

- 1) Water-Based Primer: None required for Air Shield LMP.
- 2) Solvent-Based Primer: None required for Air Shield LMP.
- 3) Solvent-Based Aerosol Primer: None required for Air Shield LMP.
- 4) Termination Mastic: Pointing Mastic or BEM.
- 5) Transition Membrane for details and terminations: Air Shield.
- 6) Reinforcing / Joint Tape: Reinforcing Fabric HCR.
- 7) Flashing at Transition Membrane: Air Shield Thru-Wall Flashing.
- 8) Counter-flashing for Masonry Through-Wall Flashings: Air Shield Thru-Wall Flashing.
- 9) Through-Wall Flashings or Shelf Angle Flashings: Air Shield Thru-Wall Flashing.
- 10) Solvent-Based Primer for Flashing, Transition Strip and Detail Membrane: Mel-Prime VOC.
- 11) Water-Based Primer for Flashing, Transition Strip and Detail Membrane: Mel-Prime WB.
- 12) Substrate Joint Treatment: Air Shield Joint Filler.

2.2 AUXILIARY MATERIALS

- A. Transition Membrane Between Air and Vapor Barrier Membrane and Roofing and Other Adjacent Materials: Comply with both air barrier Manufacturer's recommendations and roofing material Manufacturer's recommendations.
- B. Provide primers, glass fabric scrim tape, mastic, and other materials not specifically described, but required for a complete and proper installation as instructed by the air barrier system Manufacturer or required to provide a continuous the air barrier assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The ABAA Certified Air Barrier Contractor shall examine substrates, areas, and conditions under which the air barrier assembly will be installed, with ABAA Certified Installer present, for compliance with requirements.
 1. Confirm site access logistics and scheduling requirements, including but not limited to use of scaffolding, lifts and staging.
 2. Verify that surfaces and conditions are suitable prior to commencing work of this section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3. Ensure that the following conditions are met:
 - a. Surfaces are sound, dry, even, and excess mortar and / or other contaminants.
 - b. Inspect and confirm substrates to be smooth and without large voids or sharp protrusions. Inform General Contractor if substrates are not acceptable and need to be repaired by the substrate Subcontractor.
 - c. Inspect and confirm masonry joints to be reasonably flush and completely filled, and ensure all excess mortar accumulated on masonry ties has been removed. Inform General Contractor if masonry joints are not acceptable and need to be repaired by the masonry Subcontractor.
 - d. Masonry joints are flush and completely filled with mortar, and all excess mortar sitting on masonry ties has been removed.
4. Verify substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 and take suitable measures until substrate passes moisture test.
5. Verify sealants are compatible with membrane proposed for use. Perform field peel-adhesion test on materials to which sealants are adhered.
6. Notify Architect in writing of anticipated problems using air and vapor barrier over substrate prior to proceeding.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to material Manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.
 1. Ensure that penetrating work by other trades is in place and complete.
 2. Prepare surfaces by brushing, scrubbing, scraping, grinding or compressed air to remove loose mortar, dust, oil, grease, oxidation, mill scale and other contaminants which will affect adhesion of the fluid-applied membrane.
 3. Wipe down metal surfaces to remove release agents or other non-compatible coatings using clean sponges or with a material chemically compatible with the primary air material.
- B. Prime substrate for installation of sheet membrane transition strips as recommended by material Manufacturer and as follows:
 1. Prime masonry, concrete substrates with conditioning primers.
 2. Prime glass-fiber surfaced gypsum sheathing an adequate number of coats to achieve required bond, with adequate drying time between coats.
 3. Prime wood, metal, and painted substrates with primer.
 4. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air barrier at protrusions.
- C. Prime substrate for installation of fluid-applied air barrier if recommended by material Manufacturer based on project conditions.
- D. Protection from spray-applied materials as recommended by material Manufacturer and as follows:
 1. Mask and cover adjacent areas to protect from over-spray.
 2. Ensure any required foam stop or back up materials are in place to prevent over-spray and achieve complete seal.

3.3 INSTALLATION

- A. Fluid Applied Membrane Air Barrier: Install air barrier accessories and fluid-applied membrane air barrier material to provide continuity throughout the building envelope in a shingle fashion. Install materials in accordance with material Manufacturer's instructions and the following (unless

Manufacturer recommends other procedures in writing based on project conditions or particular requirements of their recommended materials):

1. Install veneer anchors as per air barrier Manufacturer installation sequencing.
2. Apply treatment to exterior gypsum joints and screw heads as per air barrier material Manufacturer.
3. Apply primer for transition material at the rate instructed by the air barrier material Manufacturer for 1 inch beyond terminating edge of transition membrane. Allow primer to set / cure completely before transition strip application.
4. Position subsequent sheets of transition material so that membrane overlaps the membrane sheet below by a minimum of 2 inches, unless greater overlap is recommended by the material Manufacturer. Ensure transition membrane is securely sealed onto substrate with roller.
5. Overlap horizontally adjacent pieces of transition material a minimum of 2 inches, unless greater overlap is recommended by the material Manufacturer. Roll all areas of transition strip including seams with roller.
6. Seal around all penetrations with termination mastic / sealant, membrane counterflashing or other procedure in accordance with material Manufacturer's instructions, ensuring chemical compatibility amongst adjoining materials.
7. Connect air barrier in exterior wall assembly continuously to the air barrier of the roof, to concrete below-grade structures, to windows, curtain wall, storefront, louvers, exterior doors, other intersection conditions and transitions from wet cavity to dry cavity and seal penetrations using accessory materials in accordance with the material Manufacturer's instructions.
8. Provide transition material at changes in substrate plane (with bead of sealant / mastic, membrane counter-flashing or other material recommended by material Manufacturer) under membrane to eliminate all sharp 90 degree inside corners and to make a smooth transition from one plane to another.
9. Provide mechanically fastened non-corrosive metal sheet or other Manufacturer approved transition material to span gaps greater than 1 inch in substrate plane and to make a smooth transition from one plane to the other. Transition membrane shall be installed continuously from air barrier material onto sheet metal maintaining 2 inch overlap on both edges.
10. Lap transition material over top edge of through-wall flashing and head-flashing.
11. Provide backup for the membrane to accommodate anticipated movement or use other Manufacturer approved transition material at deflection and control joints.
12. Provide transition material to joint assemblies at expansion and seismic joints.
13. Provide backup for the fluid applied air barrier to accommodate anticipated movement at deflection and control joints as recommended by material Manufacturer.
14. Apply a bead or trowel coat of mastic along membrane seams at reverse lapped seams, rough cuts, and / or as otherwise recommended by the material Manufacturer.
15. Seal top edge of the self-adhered membrane to substrate with termination mastic at end of each working day.
16. Inspect installation prior to enclosing assembly and repair punctures, damaged areas and inadequately lapped seams with a patch of membrane lapped as recommended by material Manufacturer.
17. Install primer for fluid-applied air barrier if instructed by material Manufacturer.
18. Install fluid-applied membrane using equipment and methods recommended by Manufacturer to achieve a dry film thickness as required by the material Manufacturer.
19. Do not allow materials to come in contact with chemically incompatible materials.
20. Do not expose membrane to sunlight / ultraviolet light longer than as recommended by the Manufacturer.

3.4 FIELD QUALITY CONTROL

- A. Owner's Inspection and Testing: Cooperate with Owner's testing agency as applicable. Allow access to work areas and staging. Notify Owner's testing agency in writing of schedule for Work of this Section to allow sufficient time for testing and inspection. Do not cover Work of this Section until testing and inspection is accepted.
- B. Manufacturer's Field Representative Review: Contractor is not to commence any work other than staging until contact and meeting with the Manufacturer's Field Representative on site. The Manufacturer's Field Representative is to visit the jobsite a minimum of four (4) times to review work processes and / or work completed prior to work commencement, at 10% completion, at 50% completion and prior to the work being covered by finish materials.

3.5 PROTECTING AND CLEANING

- A. Protect air barrier materials from damage during installation and the remainder of the construction period, according to material Manufacturer's written instructions.
 - 1. Coordinate with installation of materials which cover the air barrier assemblies, to ensure exposure period does not exceed that recommended by the air barrier Manufacturer.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by Manufacturer of affected construction and acceptable to the primary material Manufacturer.

END OF SECTION 07 27 26

SECTION 07 41 13 - PREFINISHED METAL ROOFING

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Furnish all labor, materials, tools, equipment and services for all preformed roofing as indicated.
- B. Coordinate with work of other trades.
- C. It is the intent of this Section that the Work shall:
 - 1. conform to all applicable building code requirements and of authorities having jurisdiction;
 - 2. include, but not limited to:
 - a. Preformed, prefinished metal roof panels
 - b. Flashings
 - c. Gutters, Downspouts and Splash Blocks
 - d. All supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, weathertight, and complete installation.
 - 3. be performed by a single source contractor.

1.2 RELATED WORK

- A. Division 5 Sections as required; generally: structural steel, steel joists, and miscellaneous metals.
- B. Section 06 10 00 - Rough Carpentry
- C. Section 07 62 00 - Sheet Metal Flashing, Gutters, Downspouts and Trim
- D. Divisions 22, 23 and 26: All Sections of Work relating to or affecting the roofing system, including mechanical, plumbing and electrical items penetrating roofing system.

1.3 REFERENCES

- A. American Institute of Steel Construction (AISC)
 - 1. Manual of Steel Construction
- B. American Iron and Steel Institute (AISI)
 - 1. Cold Formed Steel Design Manual
- C. ASTM International (ASTM)
- D. A792, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
- E. E108, Standard Test Methods for Fire Tests of Roof Coverings
- F. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

- G. E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
- H. E1514, Standard Specification for Structural Standing Seam Steel Roof Panel Systems
- I. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
- J. Factory Mutual Research Corporation (FM) (FMRC)
Class 1-90 Windstorm Rating
Class 1-SH (Test 4471) Hail Damage Rating
- K. International Conference of Building Officials (ICBO)
ICBO Evaluation Services, Inc. Report No. ER-5409
- L. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
1. Architectural Sheet Metal Manual
- M. ASCE-7 Wind uplifts requirements for geographical area.
- N. International Building Code

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturer must have a minimum of three (3) years experience manufacturing roof panels of the type specified for this Project. Panels specified in this Section shall be produced in a factory environment or by manufacturer's certified and approved on-site roll forming equipment to assure the highest level of quality control. A letter certifying compliance should accompany the product material submittal.
- B. Installer's Qualifications:
 - 1. Installer of the system shall be an approved installer, certified and authorized by the manufacturer as trained and qualified to install the manufacturer's product. Provide a letter of certification from manufacturer that installer has a minimum of three (3) year of metal roof panel installation experience preceding the date upon which work is to commence.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

- A. Performance Testing:
 - 1. All panels must be FM Class 1-90 Windstorm Rating tested. Roofing system shall be installed in accordance with ASCE-7 wind uplift requirements for geographical location and a 150 MPH 3-second gust wind speed zone, Exposure B with a Risk Category III based on IBC requirements. Wind-resistance loads listed below have a safety factor of 2.0 incorporated into the calculation.
 - a. Zone 1 Field 48.6 or as otherwise indicated by Structural
 - b. Zone 2 Perimeter 81.5 or as otherwise indicated by Structural
 - c. Zone 3 Corner 122.6 or as otherwise indicated by Structural
 - 2. Panel system shall have an FM Hail Damage Rating of Class 1-SH (Test 4471).
 - 3. Panel system shall have a Class "A" Fire Rating in accordance with ASTM E108.

4. Metal roof system must be installed to resist the roof design pressures calculated in accordance with IBC or authorities having jurisdiction. Determine panel bending and clip-to-clip strength by testing in accordance with ASTM E1592. Capacity for gauge, span or loading other than those tested may be determined by interpolating test results by engineer supplying calculations.
5. Metal roof system must meet the air infiltration requirements of ASTM E283 when tested with a 6.24 PSF pressure differential with resulting air infiltration of 0.0071 cfm/sq. ft.
6. Metal roof system must meet the water penetration requirements of ASTM E331 when tested with a 12.00 PSF pressure differential with no uncontrollable water leakage when five (5) gallons per hour of water is sprayed per square foot of roof area.
7. ICBO Evaluation Services, Inc. Report No. ER-5409 is in compliance with UBC authorities having jurisdiction.

1.6 SUBMITTALS

- A. Product Data:
 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 2. Manufacturer's installation instructions.
- B. Shop Drawings: Include layouts of panels, details of edge conditions, joints, corners, custom profiles, supports, anchorages, trim, flashing, closures and special details. Distinguish between factory and field assembly work.
- C. Calculations: All calculations shall be sealed by a professional engineer licensed in the State of Texas. Engineering calculations defining cladding loads on all roof areas based on specified building codes, allowable clip loads and required number of fasteners to secure the panel clips to the designated substructure. Uplift loads on clip fasteners with full recognition of prying forces and eccentric clip loading. Calculate holding strength of fasteners in accordance with submitted test data provided by fastener manufacturer based on length of embedment and properties of materials.
- D. Samples:

Color charts or samples from a minimum of 18 colors of manufacturer's Kynar 500® or Hylar 5000® finishes for Architect's selection.

One (1) foot long sample of coated panel, including clips and fasteners.
- E. Certifications:
 1. Letter of certification from manufacturer that installer is in compliance and meets specified requirements.
 2. Letter of certification from manufacturer that panels have been produced in a factory environment or with certified/approved fixed-base roll forming and leveler equipment.
 3. Certified test results by a recognized testing laboratory or manufacturer's laboratory (witnessed by a professional engineer) in accordance with specified performance test methods for each panel system.
 4. Manufacturer's affidavit that materials used in Project contain no asbestos.
- F. Testing Reports: Showing metal panels have been tested in accordance with specified performance testing requirements.
- G. Warranty: Manufacturer's warranty as specified.

1.7 INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver metal roof system to job site properly packaged to provide protection against transportation damage.
- B. Handling: Exercise extreme care in unloading, storing and erecting metal roof system to prevent bending, warping, twisting and surface damage.
- C. Storage:
 - 1. Store all materials and accessories above ground on well skidded platforms.
 - 2. Store under waterproof covering.
 - 3. Provide proper ventilation of metal roof system to prevent condensation build-up between each panel or trim / flashing component.

1.9 WARRANTY

- A. Warrant the work specified herein against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials or workmanship. Warranty shall be a "Weather tightness" Warranty. Field Reports are required throughout Project and are to be supplied by a Manufacturer's Approved Technical Inspector. Manufacturer's personnel which are not Quality Control Technicians are not acceptable for inspection.
 - 1. Roof Panels and Finish:
 - a. Durability of the roof panels due to rupture, structural failure or perforation shall be warranted for a period of 20 years by the Manufacturer.
 - b. The exterior color finish for painted roof panels shall be warranted by the Manufacturer for 20 years against chalking, blistering, peeling, cracking, flaking, checking and chipping.
 - 2. Weathertightness:
 - a. The entire roof system including all roof panels, flashings, curbs, interior gutters, etc. shall be warranted by the manufacturer against leaks for a period of 20 years.
 - b. The warranty shall be issued to the Owner by the Manufacturer at time of entire Project Substantial Completion.
 - c. The warranty shall guarantee the entire roof system and associated work against defective materials and workmanship of installation.
 - d. The roof system shall include roof insulation, flashing, metal work, labor, and material shall be guaranteed against failure of workmanship and materials. Repair of the system by the manufacturer, including materials and labor, shall be done at no cost to the Owner for duration of warranty period.
 - 3. Roofing Contractor: Jointly with any subcontractors employed by him, shall guarantee the work required and performed under this contract will be free from defects in workmanship and materials, and that the building will be and remain waterproof for a five (5) year warranty period, after the Architect accepts the work as substantially complete. The warranty shall be in approved notarized written form, to obligate the Contractor, and subcontractors, to make good the requirements of the warranty. The warranty will be held jointly with the Bonding Company for the first two (2) years and the manufacturer for the remaining three (3) years.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Manufacturers listed who produce products equivalent to those specified are approved for use on the Project. Other manufacturers must have a minimum of ten (10) years experience manufacturing equivalent products to those specified and comply with requirements of Division 1 regarding substitutions to be considered.
 - 1. AEP-Span, Dallas, TX; (214) 827-1740
 - 2. Architectural Building Components, Inc., Houston, TX; (800) 423-1105
 - 3. RollCOM, a Centria Company, Frankfort, KY; (888) 647-4084
 - 4. MBCI, Houston, TX; (281) 445-8555
 - 5. UNA-CLAD Anoka Minnesota 800-426-7737
 - 6. Pac Clad , Tyler Texas 1-800-441-8661
 - 7. McElroy Metal, Bossier City, LA 800-950-6531
- B. Specifications are based on "238T" architectural structural standing seam metal roof system manufactured by McElroy Metal.
- C. Materials shall be manufactured, specified, or accepted in writing by Roofing Manufacturer issuing the warranty. Proposed materials shall ensure full system warranty from said Manufacturer.
- D. Roof panels with lap type side joints or those requiring battens or other non-integral sealing means or exposed structural fasteners will not be acceptable.
- E. Roof panels shall be roll formed in the Manufacturer's plant to control quality or by certified / calibrated / approved on-site roll-forming equipment only by panel Manufacturer's approved installers.
- F. Substitute Manufacturers will be approved by written addendum to all bidders. Voluntary alternates will not be considered. Substitutions will not be permitted after the bid date of this project.
- G. Roof panels proposed for substitution shall fully comply with specified requirements in performance.

2.2 MATERIALS

- A. Metal Roof Panels:
 - 1. Profile / Dimensions: 2 3/8" high vertical legs shall be spaced at 18 inches on-center striated panel in continuous length with mechanically seamed sidelaps.
 - 2. Metal Roof System: Vertical leg, concealed fastener, standing seam, symmetrical rib configurations, with factory applied sealant / butyl in rib, continuously locked together by an electrically powered mechanical seaming device during installation.
 - 3. Gauge: Minimum 24 gauge (UL 90 rated)
 - 4. Substrate: Galvalume® steel sheet, Grade "D" minimum yield of 50,000 PSI.
 - 5. Clips: Two (2) piece floating clip, 18 gauge base, 24 gauge top, with factory applied mastic, with fasteners to structural.
 - 6. Texture: Striations.
 - 7. Finish: Full strength Kynar 500 or Hylar 5000 Fluoropolymer coating, applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat, to provide a total dry film thickness of 0.95 to 1.25 mil. Bottom side shall be coated with primer with a dry film thickness of 0.25 mil. Finish shall conform to tests for adhesion, flexibility, and longevity as specified by the Kynar 500 or Hylar 5000 finish supplier. Color

shall be selected by Architect from manufacturer's full range of non-metallic colors. (20 year warranty)

8. Touch-up Paint: Paint burns, scars, welds, and damaged and rusted surfaces with cold galvanizing paint in accordance with ASTM A780. Acceptable Products include ZRC Cold Galvanizing Compound manufactured by ZRC Chemical Products, Quincy, MA; Galvax Zinc-rich Cold Galvanizing Coating manufactured by Alvin Products, Inc., Lawrence, MA; or paint complying with military specification MILP-21035A, Type I or II.

2.3 MISCELLANEOUS MATERIALS

- A. Fasteners: All self-tapping/self-drilling fasteners, bolts, nuts, self-locking rivets and other suitable fasteners shall be designed to withstand specified design loads.
 1. Use long life fasteners for all exposed fastener applications.
 2. Provide fasteners with a factory applied coating in a color to match metal roof system application.
 3. Provide neoprene washers under heads of exposed fasteners.
 4. Locate and space all exposed fasteners in a true vertical and horizontal alignment. Use proper torque settings to obtain controlled uniform compression for a positive seal without rupturing the neoprene washer.
 5. Fasteners used to attach metal "Z" purlins shall be size and type recommended by manufacturer to achieve FM 1-90 requirements.
- B. Accessories:
 1. General: Provide all components required in accordance with the metal roof system manufacturer's approved shop drawings for a complete metal roof system to include panels, panel clips, trim/flashings, fascias, ridge, closures, sealants, fillers, and other required items.
 2. Closures: All outside closures shall be fabricated from Galvalume® sheet steel of the same gauge, finish and color as the panels. Galvanized base is unacceptable.
 3. Tape Seal: Shall be a pressure sensitive, 100 percent solids, polyisobutylene compound sealing tape with a release paper backing. Provide permanently elastic, non-sagging, non-toxic, non-staining tape seal approved by the metal roof system manufacturer.
 4. Joint Sealant: Shall be a one-part elastomeric polyurethane sealant approved by the metal roof system manufacturer.
 5. Splash Blocks: Shall be as specified in Section 07 62 00, Sheet Metal Flashing, Gutters, Downspouts and Trim.

2.4 FABRICATION

- A. Material shall be in-line tension leveled prior to roll forming panel profile.
- B. Roll form panels in continuous lengths, full length of detailed runs.
- C. Standard panel length shall be 45 feet, unless approved by the metal roof system manufacturer.
- D. Fabricate trim/flashings and accessories to detailed profiles.
- E. Fabricate trim/flashings from same material as panel.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Inspect installed work of other trades and verify that such work is complete to a point where this work may continue.
- B. Verify that installation may be made in accordance with approved shop drawings and manufacturer's instructions. This specifically includes verifying the secondary structurals and/or decking are installed to meet building code requirements. Coordinate with metal roof system manufacturer to insure that reduced clip spacings at eave, rake, ridge and corner areas are accommodated. Supply calculations, sealed by a professional engineer licensed in the State of Texas, showing required clip spacings.
- C. Discrepancies:
 - 1. Bring discrepancies to the attention of the Architect.
 - 2. Do not proceed with installation until discrepancies have been resolved.

3.2 INSTALLATION OF METAL ROOFING OVER METAL DECK

- A. Install metal deck to structure to meet ASCE-7 wind uplift requirements.
- B. If shown or required, install insulation over metal deck in conformance with approved shop drawings and manufacturer's instructions.
- C. If shown or required, install substrate board over insulation in conformance with approved shop drawings and manufacturer's instructions.
- D. If shown or required, install waterproofing membrane barrier over substrate board in conformance with approved shop drawings and manufacturer's instructions. Lap and tape seal all joints.
- E. Remove protective strippable plastic film covering from metal roof panels, trim, and related items in accordance with manufacturer's instructions.
- F. Install metal roof system so that it is weathertight, without waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction. Isolate dissimilar metal contact with proper taping and / or coatings.
- G. Install metal roof panels, trim, and related items in accordance with approved samples with approved shop drawings and manufacturer's instructions.
- H. Provide concealed anchors at all panel attachment locations.
- I. Install panels plumb, level and straight with seams and ribs parallel, conforming to design as indicated.
- J. Install roof jacks in accordance with approved shop drawings and manufacturer's instructions.
- K. Install roof curbs in accordance with approved shop drawings and manufacturer's instructions. Anchor curbs securely in place with provisions for thermal and structural movement. Provide prefinished metal cover around all curbs to match color and finish of metal roof panels.

- L. Install gutters and downspouts in accordance with approved samples with approved shop drawings and manufacturer's instructions. Gutter design for required gutter and downspout sizes shall be submitted prior to installation.
- M. Install downspouts plumb and level, attached to columns or wall with straps located at top and bottom of downspout and maximum ten (10) feet on center.
- N. Install splash block under discharge port of downspouts.
- O. Install gutter screen over installed gutter. Secure screen to spacer with self-tapping screw.
- P. Provide expansion joints on ends of gutters spaced maximum 50 feet on center. Install snap-on cover over expansion joint.

3.3 CLEANING AND PROTECTION

- A. Remove scraps and debris and leave work area clean.
- B. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes. Paint areas where finish is damaged on prefinished metal by painting with a compatible paint in color to match undamaged finish.
- C. Clean other work damaged or soiled by Work of this Section.
- D. Protect finished work from damage.

3.4 INSPECTION

- A. Architect and Contractor reserve the right to inspect the work during application. Upon completion of the work, if inspection discloses that roofing is not according to specifications or has been damaged, Contractor agrees to furnish additional materials necessary to make repairs and place work in an acceptable condition at no additional expense to Owner.

END OF SECTION 07 41 13

SECTION 07 42 13 - FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exposed-fastener, lap-seam, metal roof panels.

1.3 DEFINITIONS

- A. Comparable Product: Product demonstrated and approved through submittal process, or where indicated as a produce substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
 - 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 7. Review temporary protection requirements for metal panel assembly during and after installation.
 - 8. Review of procedures for repair of metal panels damaged after installation.
 - 9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.
1. Include Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockup of typical metal panel assembly as shown on Drawings, including corner, soffits, supports, attachments, and accessories.
 2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.11 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 EXPOSED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. General: Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
- B. Corrugated-Profile, Exposed-Fastener Metal Wall Panels: Formed with alternating curved ribs spaced at 2.67 inches (68 mm) o.c. across width of panel.
 1. Basis of Design: Centria BR5-36. Other manufacturers are subject to compliance with requirements, provide products by one of the following:
 - a. Alcoa Architectural Products (USA).
 - b. Alcotex Inc.
 - c. ALPOLIC Materials; Mitsubishi Plastics Composites America.
 - d. ALUCOBOND; 3A Composites USA, Inc.
 - e. Alucoil North America.
 2. Aluminum Sheet: Coil-coated sheet, ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 - a. Thickness: 0.40" thick.
 - b. Surface Finish: Smooth.
 - c. Exterior Finish: 1 mil PVDF Kynar 500 or Hylar 5000 coating as selected by Architect from manufacturer's full line.
 - d. Color: As selected by Architect from manufacturer's full range.
 3. Panel Coverage: 36 inches (914 mm).
 4. Panel Height: 1.50 inches (38 mm).
 5. Panel Width: 36 inch.
 6. Panel Length: As indicated on the Drawings.
 7. Panel Depth: 1-1/2 inch.
 8. Rib Spacing: 5 at 7.20 inches (183 mm) o.c.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation

unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 4. Preformed 90-degree corners: "Microseam Corner" by Centria, as the Basis of Design.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
 - 1. Mica Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

- a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.
- D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 13

SECTION 07 42 16 - METAL COMPOSITE MATERIAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Metal composite material wall panels.
 - 2. Accessories necessary for a complete installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the State of Texas with experience in the design of metal composite wall panels as part of curtainwalls and aluminum storefront systems to design and coordinate the cladding assembly using performance requirements and design criteria indicated.
- B. Structural Performance: Provide metal composite material panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:
 - 1. Wind Loads: Indicated on Drawings.
 - 2. Other Design Loads: Indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test Pressure Difference: 1.57 lbf/sq. ft. (75 Pa) and 6.24 lbf/sq. ft. (300 Pa).
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 - 1. Test Pressure Difference: 2.86 lbf/sq. ft. (137 Pa) and 6.24 lbf/sq. ft. (300 Pa).
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.
- F. Fire Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from ULI *Fire Resistance Directory* or from the listings of another qualified testing agency.
- G. Fire Propagation Characteristics: Metal composite material wall panel system passes NFPA 285 testing.

1.4 SUBMITTALS

- A. Product Data: Technical data including construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

- B. Shop Drawings: Submit fabrication and installation layouts of metal composite material panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
 - 1. Accessories: Include details of the flashing, trim and anchorage, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples: Submit MCM panel samples, 12 inches (305 mm) long by actual panel width with fasteners, closures, and other metal composite material panel accessories.
- D. Qualification Data: Submit Installer's qualifications.
- E. Product Test Reports: Submit copy of required tests performed by a qualified testing agency within the past 36 months.
- F. Field quality control reports.
- G. Maintenance Data: Submit maintenance data for metal composite material panels for inclusion in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements of IBC for building cladding.
 - 2. Energy Code: Comply with applicable provisions of the IECC.
 - 3. Surface Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: 25 or less.
 - b. Smoke Developed Index: 450 or less.
 - 4. Fire Propagation Characteristics: Metal composite material wall panel system passing NFPA 285 testing.
 - 5. Welding Standards: Welding shall be performed by skilled and qualified mechanics. Welding shall be performed in accordance with the applicable provisions of AWS D1.1 *Structural Welding Code - Steel* and AWS D1.2 *Structural Welding Code - Aluminum*.
- B. Installer Qualifications: Entity having minimum 5 years documented experience that employs installers and supervisors who are trained and approved by manufacturer.
- C. Mockups: Build mockups to verify selections and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical metal composite material panel assembly shown on Drawings, including corner, soffits, supports, attachments, and accessories.
 - 2. Water Spray Test: Conduct water spray test of mockup of metal composite material panel assembly, testing for water penetration according to AAMA 501.2.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. Preinstallation Conference: Conduct conference at site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal composite material panels, and manufactured items to prevent damage or deformation. Package metal composite material panels for protection during transportation and handling.
- B. Unload, store, and erect metal composite material panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal composite material panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal composite material panels to ensure dryness, with positive slope for drainage of water. Do not store metal composite material panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal composite material panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation when existing and forecasted weather conditions permit assembly of metal composite material panels to be performed according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate metal composite material panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Written warranty signed by manufacturer in which manufacturer agrees to repair or replace components of metal composite material panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Ten (10) years from date of Substantial Completion.
- B. Panel Finishes: Written warranty signed by manufacturer in which manufacturer agrees to repair finish or replace metal composite material panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: Twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL COMPOSITE MATERIAL WALL PANELS

- A. Metal Composite Material Wall Panel Systems: Provide factory-formed and -assembled, metal composite material wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Alcoa Architectural Products (USA).
 - b. Alcotex Inc.
 - c. ALPOLIC Materials; Mitsubishi Plastics Composites America.
 - d. ALUCOBOND; 3A Composites USA, Inc.
 - e. Alucoil North America.
 - f. CENTRIA Architectural Systems.
 - g. Citadel Architectural Products, Inc.
- B. Aluminum Faced Composite Wall Panels: Formed with 0.020 inch (0.50 mm) thick, anodized aluminum sheet facings.
 - 1. Panel Thickness: 0.157 inch (4 mm).
 - 2. Core: Fire retardant.
 - 3. Exterior Finish: Two coat fluoropolymer.
 - a. Color: Selected by Architect from manufacturer's full range.
- C. Attachment Assembly Components: Formed from material compatible with panel facing.
- D. Attachment Assembly: Clip.
- E. Miscellaneous Materials:
 - 1. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold formed, metallic coated steel sheet ASTM A 653/A 653M, G90 (Z275 hot dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) aluminum zinc alloy coating designation unless otherwise indicated. Provide sections necessary for support and alignment of metal composite material panel system.
 - 2. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal composite material panels unless otherwise indicated.
 - 3. Flashing and Trim: Provide flashing and trim formed from same material as metal composite material panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal composite material panels.
 - 4. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal composite material panels by means of plastic caps or factory applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
 - 5. Panel Sealants: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal composite material panels and remain weathertight; and as recommended in writing by metal composite material panel manufacturer.

2.2 FABRICATION

- A. Fabricate and finish metal composite material panels and accessories at the factory, using procedures and processes necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Fabricate metal composite material panel joints with factory installed captive gaskets or separator strips that provide a weathertight seal and prevent metal to metal contact, and that minimize noise from movements.
- C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in *SMACNA Architectural Sheet Metal Manual* that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: Recommended by *SMACNA Architectural Sheet Metal Manual* or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.3 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
 - 1. Two Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal composite material panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal composite material wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal composite material wall panel manufacturer.
 - a. Verify that air or water resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing in for components and assemblies penetrating metal composite material panels to verify actual locations of penetrations relative to seam locations of metal composite material panels before installation.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal composite material panel manufacturer's written recommendations.

3.3 METAL COMPOSITE MATERIAL PANEL INSTALLATION

- A. Install metal composite material panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to supports unless otherwise indicated. Anchor metal composite material panels and other components of the work securely in place, with provisions for thermal and structural movement.
 1. Shim or otherwise plumb substrates receiving metal composite material panels.
 2. Flash and seal metal composite material panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air or water resistive barriers and flashings that will be concealed by metal composite material panels are installed.
 3. Install screw fasteners in predrilled holes.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Install flashing and trim as metal composite material panel work proceeds.
 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 7. Align bottoms of metal composite material panels and fasten with blind rivets, bolts, or self tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 8. Provide weathertight escutcheons for pipe and conduit penetrating panels.
- B. Fasteners:
 1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized steel fasteners for surfaces exposed to the interior.
 2. Copper Panels: Use copper, stainless steel or hardware-bronze fasteners.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal composite material panel manufacturer.
- D. Attachment Assembly, General: Install attachment assembly required to support metal composite material wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
 1. Include attachment to supports, panel to panel joinery, panel to dissimilar material joinery, and panel system joint seals.

- E. Installation: Attach metal composite material wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.
 - 1. Wet Seal Systems: Seal horizontal and vertical joints between adjacent metal composite material wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200.
 - 2. Dry Seal Systems: Seal horizontal and vertical joints between adjacent metal composite material wall panels with manufacturer's standard gasket system.
- F. Clip Installation: Attach panel clips to supports at locations, spacings, and with fasteners recommended by manufacturer. Attach routed and returned flanges of wall panels to panel clips with standard fasteners.
 - 1. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200.
 - 2. Seal horizontal and vertical joints between adjacent metal composite material wall panels with manufacturer's standard gaskets.
- G. Subgirt and Spline Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard subgirts and splines that provide support and complete secondary drainage assembly, draining to the exterior at horizontal joints. Attach metal composite material wall panels by interlocking perimeter extrusions attached to panels with subgirts and splines. Fully engage integral subgirt and spline gaskets and leave horizontal and vertical joints with open reveal. Terminate edge of panels flush with perimeter extrusions.
 - 1. Install wall panels to allow individual panels to free float and be installed and removed without disturbing adjacent panels.
 - 2. Do not apply sealants to joints unless otherwise indicated.
- H. Track Support Installation: Install support assembly at locations, spacings, and with fasteners recommended by manufacturer. Use manufacturer's standard horizontal tracks and vertical tracks that provide support and secondary drainage assembly, draining to the exterior at horizontal joints through drain tube. Attach metal composite material wall panels to tracks by interlocking panel edges with manufacturer's standard "T" clips.
 - 1. Attach routed and returned flanges of wall panels to perimeter extrusions with manufacturer's standard fasteners.
 - 2. Attach flush wall panels to perimeter extrusions by engaging panel edges and by attaching with manufacturer's standard structural silicone adhesive.
 - 3. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
 - 4. Do not apply sealants to joints unless otherwise indicated.
- I. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal composite material panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal composite material panel manufacturer; provide types recommended in writing by metal composite material panel manufacturer.
- J. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA *Architectural Sheet Metal Manual*. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (605 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal composite material wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and location lines as indicated, and within 1/8 inch (3 mm) offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform field tests and inspections.
- B. Water Spray Test: After installation, test area of assembly directed by Architect for water penetration according to AAMA 501.2.
- C. Manufacturer Field Service: Engage a factory authorized service representative to test and inspect completed metal composite material wall panel installation, including accessories.
- D. Metal composite material wall panels are considered defective if they do not pass test and inspections.
- E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films as metal composite material panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal composite material panel installation, clean finished surfaces as recommended by metal composite material panel manufacturer. Maintain in a clean condition during construction.
- B. After metal composite material panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal composite material panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 42 16

SECTION 07 54 19 - FULLY ADHERED THERMOPLASTIC HYBRID MEMBRANE ROOFING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Providing the entire roofing assembly, including, but not limited to:
 - 1. Tapered edge strips, cant strips, and wood nailers. (Refer to this Section and Section 06 10 00)
 - 2. Curbs (Refer to Section 07 72 00)
 - 3. Fully adhered thermoplastic single-ply membrane roofing
 - 4. Flashings, including sheet metal perimeter edge (fascia) (Refer this Section and Section 07 63 00)
 - 5. Walkway pads, expansion joints, and other work incidental to, the complete and proper installation of a watertight roofing system as shown on the drawings or specified herein, and in accordance with all applicable requirements of the Contract Documents.
- B. It is the intent of this Section that the Work shall:
 - 1. Provide a watertight facility.
 - 2. Conform to all applicable building code requirements and of authorities having jurisdiction.
 - 3. Include Section 07 63 00, and Section 07 72 00, as part of the Work of this Section; and be performed by a single source contractor.
 - 4. Coordinate with General Contractor of temporary equipment and conduit on roof and protection of installed roof membrane.

1.2 RELATED WORK

- A. All Sections of Work relating to the roofing system, including mechanical, plumbing and electrical items penetrating the roof system.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
 - 2. D570, Water Absorption of Plastics
 - 3. D638, Tensile Properties of Plastics
 - 4. D751, Method of Testing Coated Fabrics
 - 5. D882, Tensile Properties of Thin Plastic Sheeting
 - 6. D1004 Initial Tear Resistance of Plastic Film and Sheeting
 - 7. D1204 Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
 - 8. D2136 Coated Fabrics – Low-Temperature Bend Test
 - 9. D2565 Operating Xenon Arc-Type Light Exposure Apparatus With and Without Water for Exposure of Plastics
 - 10. D3045 Heat Aging of Plastics Without Load
 - 11. D4434 Poly (Vinyl Chloride) Sheet Roofing
 - 12. E108 (Rev. A) Fire Tests of Roof Coatings
 - 13. G21 Determining Resistance of Synthetic Polymeric Materials to Fungi
 - 14. G53 Operating Light – and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
- B. ASCE-7 Wind uplifts requirements for geographical area.
- C. Federal Specifications (FS)
 - 1. TT-S-00230C

FULLY ADHERED THERMOPLASTIC HYBRID MEMBRANE ROOFING SYSTEM

- D. National Roofing Contractors Association (NRCA)
 - 1. Roofing and Waterproofing Manual
- E. Single Ply Roofing Institute (SPRI)
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 1. Architectural Sheet Metal Manual
- G. Underwriters' Laboratories (UL)
 - 1. Fire Hazard Classifications
- H. International Building Code

1.4 PERFORMANCE REQUIREMENTS

- A. General Requirements: Provide an installed thermoplastic single ply roofing system, flashing and related work that are watertight and will not permit the passage of liquid water, which will withstand wind loads, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.
- C. Roofing System Design: Comply with SPRI "Wind Design Guide for Fully Adhered Roofing Systems" for the following ground roughness exposure and system design:
 - 1. Check for geographical exposure (i.e. Exposure B: City, suburban areas, towns and wooded terrain.)
 - 2. Fully Adhered single-ply membrane roofing.
- D. Underwriter's Laboratories Inc. (UL)
 - 1. UL RMSD – Current Roofing Materials and Systems Directory
 - 2. UL Fire Resistance of Roofing Coverings Materials
 - 3. Exterior Fire Exposure Classification: Class A, ASTM E 108, for application and slopes shown.
- E. ASCE-7 Wind uplifts requirements for geographical area.
- F. American National Standards Institute (ANSI)
- G. American Architectural Manufacturer's Association (AAMA)
- H. Occupational Safety and Health ACT (OSHA)

1.5 SUBMITTALS

- A. Product Data: Manufacturer's printed instructions, schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, adhesive, and accessories to be used in the Work.
- B. Certifications:
 - 1. Manufacturer's written certification that installer is approved and licensed to install specified roofing system. (Submit a copy with Proposal Form)
 - 2. Manufacturer's affidavits that materials used in Project contain no asbestos.
 - 3. Installer shall submit resume and project experience list for proposed system for Project Manager and job site superintendent.

FULLY ADHERED THERMOPLASTIC HYBRID MEMBRANE ROOFING SYSTEM

4. Installer shall submit written certification that there are no undocumented workers being employed by them or any subcontractor on this project and that covers all workers on this project by workmen's compensation.
 5. Installer shall submit list of all subcontractors with evidence of subcontractor's insurance coverage in compliance with contract requirements.
 6. Manufacturer's written certification of approval / acceptance of these specifications and details.
- C. Referenced Standards: Two (2) copies of each referenced standard and retain approved copies at site.
- D. Shop Drawings: Furnish from copies of the manufacturer's literature or from copies of NRCA "Roofing and Waterproofing Manual", fourth edition.
1. Furnish for approval any proposed details, which differ from those, included with this proposal package. All proposed details shall first be approved in writing by roofing manufacturers prior to submitting to Architect for approval.
 2. Furnish detail project sequencing, staging, material loading, manpower plans, and project construction schedule for approval.
- E. Samples:
1. Furnish copy of sample warranty that is to be issued upon project completion.
 2. Furnish samples of roof membrane.
 3. Furnish sample of metal edge to be installed.
- F. Upon Substantial Completion of Work, submit the following to Architect for his submission to Owner:
1. Manufacturer's Warranty: Manufacturer's written warranty as specified.
 2. Contractor's warranties.
 3. Maintenance Procedures: Three (3) copies of manufacturer have printed instructions for Owner's use regarding care and maintenance of roof.
 4. Affidavits of non-asbestos for material.
 5. Affidavits from the material manufacturers, suppliers and sub-contractors for release of liens.
 6. Refer to section 01 78 39 for additional requirements of close-out documents.

1.6 INSPECTIONS / TESTS

- A. The Owner's, Architect's, and Manufacturer's representative shall at all times have access to the job site and work areas. The contractor will provide proper and safe facilities for such access and inspection.
1. Owner / Architect Inspections:
 - a. The Owner / Architect will be providing periodic inspections throughout the duration of the project. Owner's / Architect's Representative shall be required to inspect after completion of each major phase of construction for approval.
 2. Manufacturer Inspections:
 - a. An inspection shall be made by a representative of the material manufacturer at appropriate intervals during performance of Work, but no less than three (3) visits, and at all major phases of construction, to ensure that said project is installed in accordance with the manufacturer's specifications and illustrated details. Written reports by the manufacturer shall be turned over to the Architect, on Monday following the inspection.
 - b. The authorized material manufacturer's field representative shall be responsible for:
 - 1) Keeping the Architect's representative informed after periodic inspections as to the progress and quality of the work observed.

- 2) Calling to the attention of the contractor those matters observed which are considered to be in violation of the contract requirements.
 - 3) Reporting to the Architect's representative, in writing, any failure or refusal of the contractor to correct unacceptable practices called to his attention.
 - 4) Confirming, after completion of the work and based on his observation and test, that he has observed no application procedures in conflict with these specifications. Final payment will not be released until the Architect has received all specified warranties.
- B. Any failure by the Owner's, Architect's or Manufacturer's Representative to detect, pinpoint, or object to any defect or noncompliance of these specifications of work in progress or completed work shall not relieve the contractor, or reduce, or in any way limit, his responsibility of full performance of work required of him under these specifications.
- C. Architect may require tests and inspections as necessary to verify quality of roofing materials and workmanship. If required by architect, Laboratory tests will be performed in accordance with ASTM standard procedures.
1. Owner will select testing laboratory and will pay for Work required by testing laboratory.
 2. Retest for work which fail initial tests or contractor shall pay inspections.
 3. **Non compliance with contractor requirements will result in the Architect/Owner to assign full time quality control and will be subject to reimbursement by the construction manager/contractor.**

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Classification by Underwriters' Laboratories, Inc. as a Class A roof covering.
 2. Roofing system shall be installed in accordance with ASCE-7-10 wind uplift requirements for geographical location of B and a 150 MPH 3-second gust wind speed zone with a Risk Category III based on IBC requirements. Wind-resistance loads listed below have a safety factor of 2.0 incorporated into the calculation.
 - a. Zone 1 Field 48.6 or as otherwise indicated by Structural
 - b. Zone 2 Perimeter 81.5 or as otherwise indicated by Structural
 - c. Zone 3 Corner 122.6 or as otherwise indicated by Structural
 3. Follow local, state, and federal regulations of safety standards and codes. Refer to applicable building code or International Building Code for roofing system installation requirements and limitations.
- B. Installer shall be an experienced single firm specializing in the type of roofing and sheet metal work required, employing only experienced workers for the class of work in which they are employed, having at least five (5) years successful experience on projects similar in size and scope and acceptable and licensed as applicators by the material manufacturer.
- C. No subcontracting of sheet metal fabrication or installation will be accepted. Contractor must have a sheet metal shop on the company premises.
- D. Contractor: The contractor is responsible for the management and control of the work. He shall give his personal superintendence of the work or have a competent resident manager or superintendent satisfactory to the Architect on the job site at all times while work is in progress, with full authority to act for the contractor as his agent.

- E. Work and materials hereinafter specified shall be best of kind described and, unless specified otherwise, shall be new and of best quality. All roofing materials utilized in performance of each type of work shall be the products of one manufacturer or supplier. Unless otherwise indicated, the materials to be used in this specification are those specified and denote the type, quality, performance, etc. required. All proposals shall be based upon the use of the specified material.
- F. Materials will be securely fastened in place in a watertight, neat and workmanlike manner. Contractor shall plan and conduct the operations of the work so that each section started on one day is complete, details installed and thoroughly protected before the close of work for that day.
- G. Application of materials shall be in accordance with the manufacturer's recommendations. In the instance of a conflict between these specifications and those of the manufacturer, the most stringent shall take precedence.
- H. Roof system shall be installed in accordance with ASCE 7 wind uplift requirements and ANSI/SPRI perimeter flashing requirements and shall meet Underwriter's Laboratory Class "A" fire rating.
- I. Contractor shall ensure that fastener pull out resistance tests on existing decks were performed and approved by Architect and coordinated with Roofing Consultant prior to starting roofing application.
- J. Contractor shall take all necessary precautions to protect the new roof mat and deck from damage. The contractor shall be responsible for repairing all new areas of damage caused by the negligence of the contractor, at the contractor's expense. The Architect's on-site representative shall determine damage caused by contractor negligence.
- K. Contractor shall keep the job clean and free from all loose materials and foreign matter. Contractor shall take necessary precautions to keep outside walls clean and shall allow no roofing materials to remain on the outside walls.

1.8 INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original unopened packaging with all tags and labels intact and legible. Carton and can labels, shall indicate appropriate warnings, storage conditions, lot numbers, and usage instructions. Handle and store materials and equipment in such a manner as to avoid damage. The proper storage of materials is the sole responsibility of the contractor. Materials damaged in shipping or storage shall not be used. Wet or damaged roofing materials shall be discarded, removed from job site, and replaced with new materials prior to application.
- B. Manufacturer's packaging and/or roll plastic is not acceptable for exterior storage. Tarpaulin with grommets shall be accepted minimum for exterior coverings. All materials stored, as above shall be minimum of four (4) inches off the substrate, and the tarpaulin tied off with rope.
- C. Products liable to degrade as a result of being frozen shall be maintained above 40° F in heated storage.

- D. Moisture sensitive products shall be maintained in dry storage areas or properly covered. Roofing insulation and felts must always be covered or stored in a dry area when not being used.
- E. No storage of materials shall be permitted on roof areas other than those materials that are to be installed the same day. Any exception must be in written form. Do not place materials or equipment in such a manner as to overload structure.

1.10 WARRANTY

- A. Roofing Manufacturer: Warrant the roofing and associated Work for 20 years from date of Substantial Completion as follows:
 - 1. The warranty shall be a NDL "No Dollar Limit" / no penal sum type, with total replacement cost.
 - 2. The warranty shall guarantee the entire roof system and associated work against defective materials and workmanship of installation, with NO exclusion for ponding water.
 - 3. The roof system including insulation, flashing, metal work, labor, and material shall be guaranteed against failure of workmanship and materials. Repair of the system, including materials and labor, shall be done at no cost to the Owner.
- B. Roofing Contractor: Jointly with any subcontractors employed by him, shall guarantee the work required and performed under this contract will be free from defects in workmanship and materials, and that the building will be and remain waterproof for a five (5) year warranty period, after the Architect accepts the work as substantially complete. The warranty shall be in approved notarized written form, to obligate the Contractor, and subcontractors, to make good the requirements of the warranty. The warranty will be held jointly with the Bonding Company for the first two (2) years and the manufacturer for the remaining three (3) years.
- C. Make arrangements with the materials manufacturer to provide the required warranty. Final warranty shall be submitted to Owner at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Compatibility: Provide materials for the roof system recommended by manufacturer(s) to be fully compatible with indicated substrates, or provide separation materials as required to eliminate contact between incompatible materials.
- B. The components of the roof system are to be products of a single manufacturer as required providing the specified system warranty.
- C. Install all materials in accordance with manufacturer's current written specifications and details. Deviations shall not be made without prior written approval from the manufacturer and the Owner's Representative. Should any specifications or details conflict with the Contract Documents, submit to Owner the recommended alternative that provides the best long term moisture protection and complies with manufacturer's warranty requirements for approval.
- D. Bitumen kettles or tankers shall have a visible thermometer and thermostatic control to provide positive monitoring of the bitumen temperature when it is heated in accordance with manufacturer's instructions. All kettles shall be equipped with afterburners to minimize fumes. Circulate bituminous materials, do not allow bituminous materials to stand in luggers for long periods. Use insulated hot transport lines and luggers. Kettle shall be kept a minimum of 20 feet away from building, placed so that fumes, odors, and smoke, do not

FULLY ADHERED THERMOPLASTIC HYBRID MEMBRANE ROOFING SYSTEM

enter building through windows, doors, fresh air vents or similar entrances; are not directed towards freshly painted or anodized surfaces, glass or other glazing materials. Do not place kettle under trees or near vegetation. The assigned kettle man shall remain in close attendance, within 25 feet of ground level, while burners are lit. Kettle lids are to remain closed except for loading. Level of bitumen shall be kept within eight (8) inches from top of kettle.

1. Asphalt Bitumen Heating: Heat and apply bitumen in accordance with equiviscous temperature method ("EVT Method") as recommended by the manufacturer. Discard bitumen that has been held at temperature, exceeding finished blowing temperature (FBT) for a period exceeding three hours. Do NOT heat bitumen to a temperature higher than 25 degrees F (14 degrees C) below flash point.
2. Asphalt Temperatures: If the EVT information is not provided, the following asphalt temperature shall be observed. Maximum heating temperature shall be 525 degrees F. Minimum application temperature shall be 400 degrees F.
3. Asphalt Moppings: Ensure that all moppings do not exceed a maximum of 25 pounds per square. Mopping shall be total in coverage, leaving no breaks or voids.

2.2 APPROVED MANUFACTURERS

- A. Specifications are based on fully adhered Thermoplastic Fleeced back single-ply roofing system (PVC) manufactured by the following Manufacturers whose products meet or exceed the specifications, who have manufactured and installed roof materials and systems of the type specified for a minimum of ten (10) years and who maintains a single source responsibility for the total roofing system, as described herein, may apply for approval as a substitution in accordance with Division 1 requirements regarding substitutions.
 1. Flex
 2. Sarnafil
 3. Johns Manville
 4. Carlisle Syn-Tec
 5. GAF- EVERGAURD
 6. Soprema
- B. All materials shall be manufactured, specified, or accepted in writing by membrane manufacturer issuing the warranty. Proposed materials shall ensure full system warranty from said manufacturer. Installer shall be an applicator licensed by the manufacturer.
- C. Samples of all materials used on the project, which are not supplied by the membrane manufacturer, shall be submitted to the membrane manufacturer for written approval prior to starting work.
- D. All materials used on the project shall be asbestos free.

2.3 ROUGH CARPENTRY

- A. All nailers, cants and wooden curbs shall be No. 2 or better treated (MCA, MCQ or Borate) lumber selected to meet design details and field dimensions and requirements of Section 06 10 00, Rough Carpentry.

2.4 ROOF MEMBRANE ASSEMBLY / UNDERLAYMENT DESCRIPTION

- A. Roofing Inter-ply Modified Bitumen Base Ply: A high performance modified bitumen base ply consisting of a reinforcing mat impregnated and coated with high quality modified bitumen: (Coordinate with manufacturer for special membrane type requirements when installed over insulation.)
 1. Flex: Flex SBS 80 Mil S/S

2. Sarnafil Product: Soprema Elastophene
3. Johns Manville: DynaBase
4. Carlisle: SureMB 90 SBS
5. GAF: Ruberoid 20
6. Soprema: Elastophene

B. Dry Sheathing Paper: (For use as a slip sheet as required) Rosin coated 5 lbs per 100 SF.

2.5 ROOF MEMBRANE ASSEMBLY / FLASHING MEMBRANE AND FINISH PLY DESCRIPTION

A. Thermoplastic Sheet: Uniform, flexible sheet formed from polyvinyl chloride, complying with ASTM D 4434-96, of the following type, thickness, and exposed face color:

1. Classification Type II, Grade - I.
2. Thermoplastic Polymer Thickness: 60 mils minimum.
3. ASCE-7 wind uplift criteria.
4. UL Class A.
5. Exposed Face Color: White

B. Physical Properties:

| <u>Property</u> | <u>Value</u> | <u>Test Method</u> |
|---|--------------|--------------------|
| Overall Thickness, mil | 0.060 | ASTM D 638 |
| Thickness Over Scrim, mil | 27 | |
| Felt Weight, oz. per sq. yd. | 9 | |
| Breaking Strength, lbf | 80 | ASTM D 751 |
| Elongation at Break, %, Machine Direction | 250 | ASTM D 751 |
| Elongation at Break, %, Cross Machine Direction | 220 | ASTM D 751 |
| Seam Strength, % of Original | Pass | ASTM D 751 |
| Retention of Properties After Heat Aging | | ASTM D 3045 |
| Tensile Strength, % of Original | Pass | ASTM D 751 |
| Elongation, % of Original | Pass | ASTM D 751 |
| Tearing Resistance, lbf | 17.5 | ASTM D 1004 |
| Low Temperature Bend at -40° F | Pass | ASTM D 2136 |
| Accelerated Weathering Test | | ASTM G 154 |
| (Fluorescent) - 10, 000 hours | Pass | |
| Cracking (7x magnification) | None | |
| Discoloration (by observation) | Negligible | |
| Crazing (7x magnification) | None | |
| Linear Dimensional Change, % | 0.02 | ASTM D 1204 |
| Weight Change after Immersion in Water, % | 1.9 | ASTM D 570 |
| Static Puncture Resistance, lbf | Pass | ASTM D 5602 |
| Dynamic Puncture Resistance, ft-lbf | Pass | ASTM D 5635 |

2.6 ROOFING SHEET METAL

A. Refer to Section 07 62 00, Roof Related Sheet Metal.

2.7 ROOF INSULATION

A. Recover Board (Unless noted otherwise): Inorganic, Glass-Faced Gypsum Roof Board equal to UL rated Type X "Dens Deck Prime" as produced by Georgia-Pacific. Board sizes shall be 48" x 96" x 1/2" or as indicated on drawings for roof assembly. 1/4" SOPRABOARD is approved substitution with Soprema roofing system. Provide as required by manufacturer recommendation primer for Roof System. Approved substitute, SECUROCK by USG.

- B. Substrate Board: Where required for fire rating or as indicated, 5/8 inch thick Gypsum Board, tapered-edged, conforming to ASTM C36, Type X. Sizes shall be 4 feet-0 inches wide by longest practical length to minimize joints.
- C. Polyisocyanurate Roof Insulation: Shall comply with ASTM C1289 and Federal Specification (FS) HH-I-1972/Gen and HH-I-1972/2, with a 20 psi minimum compressive strength. Insulation shall be surfaced on both sides with a non-asphaltic fiberglass facers. Thickness shall be a minimum of 4.4" (see plans) over all conditioned air space, see drawings for details. Approved product shall be Enrgy 3 as manufactured by Johns Manville or pre-approved equal.
- D. Tapered ISO. Insulation: Factory cut 48 inches x 48 inches polyisocyanurate board cut to 1/4 inch per foot slope; thickness varies; ASTM C1289, UL Class A, Factory Mutual Class 1. Approved product shall be Tapered E'NERGY 3 manufactured by Johns Manville or pre-approved equal. Provide 1/2 inch recovery board similar to that specified above over tapered polyisocyanurate board insulation if used.
- E. Tapered Edge Strip: 1-1/2 inches to 0 inches (or as required, field verify), 18 inches x 48 inches, install at all expansion joints, curbs, projections, crickets, saddles and base flashings. Approved material shall be as manufactured by Cant Products or pre-approved equal.

2.8 ROOFING ACCESSORIES

- A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing materials.
 - 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdictions.
- B. Flashing and Flashing Accessories: As recommended by the Thermoplastic sheet manufacturer's printed instructions for reinforced sheet flashing of same material, type, thickness, and color as sheet membrane.
- C. Mechanical Fasteners: FM Approved corrosion resistant steel screws of the appropriate size for fasteners for roof membrane and insulation attachment and for sheet metal flashing. Fasteners for the membrane shall be supplied by the thermoplastic manufacturer and are to be installed as recommended by Thermoplastic sheet manufacturer's printed instructions.
 - 1. Shall be Factory Mutual approved and supplied by the manufacturer for the specific application.
 - 2. Fastener for Brick: Zamac Nailin. Shall be 1/4 inch x 2 inches, stainless steel nail, one piece unit, flat head, as manufactured by Power Fasteners, or approved equal.
 - 3. Fastener for Metal Deck: Shall be a #14 Factory Mutual approved fastener, fluorocarbon coated, with CR-10 coating. A minimum 0.200 inch diameter shank and 0.250 inch diameter thread. To be used with Factory Mutual approved, round pressure plates or bar, and having a fluorocarbon CR-10 coating, when subjected to 30 Kesternich cycles (DIN 50018) shows less than ten percent (10%) red rust which surpasses Factory Mutual Approval Standard 4470 as manufactured by Olympic Manufacturing Group, Inc., or pre-approved equal.
 - 4. Nails: G-90 galvanized or non-ferrous type, size as required to suite application, minimum 11 gauge with 3/8 inch diameter head.
- D. Attachment Options for Recovery Board (insulation to be secured to metal deck with screws and plates):

1. Mopping Asphalt: Asphalt that has been certified for full compliance with the requirements for Type IV asphalt listed in Table I, ASTM D312. Each container or bulk shipping ticket shall indicate the equiviscous temperature EVT, the finished blowing temperature, FBT, and the flash point, FP.
 - a. Approved Product: Trumbull asphalt or as required by membrane.
 2. Low Rise Foam as recommended by Roofing manufacturer
 3. Bonding Adhesive as recommended by Roofing manufacturer
- E. Attachment Options for Modified Membrane
1. Mopping Asphalt: Asphalt that has been certified for full compliance with the requirements for Type IV asphalt listed in Table I, ASTM D312. Each container or bulk shipping ticket shall indicate the equiviscous temperature EVT, the finished blowing temperature, FBT, and the flash point, FP.
 - a. Approved Product: Trumbull asphalt or as required by membrane.
 2. Torching as recommended by Roofing manufacturer
 3. Bonding Adhesive As recommended by Roofing manufacturer
- F. Attachment Options for Thermoplastic Membrane
1. Mopping Asphalt: Asphalt that has been certified for full compliance with the requirements for Type IV asphalt listed in Table I, ASTM D312. Each container or bulk shipping ticket shall indicate the equiviscous temperature EVT, the finished blowing temperature, FBT, and the flash point, FP.
 - a. Approved Product: Trumbull asphalt or as required by membrane.
(Ensure Manufacturers product will not allow bleed through
 2. Lowrise foam as recommended by Roofing manufacturer
 3. Bonding Adhesive As recommended by Roofing manufacturer
- G. Bonding Adhesive: As recommended by thermoplastic sheet manufacturer's printed instructions to develop a bond between the membrane and the substrate to which the membrane is to be attached. Sarnacol 2121 Adhesive or approved equal.
- H. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.
- I. Metal Flashings, Copings, Edge Trim and Accessories: Provide all roofing manufacturer's metal required for a complete roofing system covered under the manufacturer's warranty.
- J. Sealants: Membrane manufacturer's approved sealant shall be used to seal penetrations through the membrane system and at miscellaneous sealant applications that come in contact with roof systems components.
- K. Air Seal Membrane: If required by manufacturer to meet wind design requirements. Air seal membrane shall be a minimum 4 mil. Polyethylene sheeting or as required by roof system manufacturer.
- L. Sealing Tape Strip: Compressible foam with pressure-sensitive tape on one side. Sealing tape strip is to be used with metal flashing as a preventive measure against air and wind blown moisture entry.
- M. Metal Reglet: Manufacturer's 6063T5 extruded aluminum counter-flashing, approximately 2.25 inches wide and 0.10 inch thick, pre-punched at 8 inches o.c. for attachment to the wall or curb. Use prefabricated mitered inside and outside corners where walls interest.

- N. Miscellaneous Accessories: Provide pourable sealants, performed cone and vent sheet flashings, pre-formed inside and outside corner sheet flashings, T-joint covers, termination reglets, and other accessories as recommended by roofing system manufacturer for intended use.
- O. Other miscellaneous materials shall be of the best grade available and approved in writing by roof system manufacturer, prior to use, for the specific application.

2.9 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Other materials shall be as shown, specified or required and be of the best grade for the proposed use as recommended by the manufacturer.
 - 1. Expansion Joint: As detailed on drawings and outlined in NRCA and SMACNA manuals.
 - 2. Sealant Backer Rod: Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable, non-absorptive material as recommended by sealant manufacturer for back-up of and compatibility with sealant. Where used with hot-applied sealant, provide heat-resistant type which will not be deteriorated by sealant application temperature as indicated.
 - 3. Pipe Hangers and Supports: Provide and install all necessary supports for gas lines, conduit, chilled water lines, duct work, condensate lines, etc. Refer to Section 07 72 00, Roof Accessories.
 - 4. Cant Strips: Shall be wood fiber where used for non-structural purposes. Shall be treated solid wood where used for structural purposes meeting NRCA, Factory Mutual and Underwriters Laboratory guidelines. If solid wood cant is used where insulation exists, cant is to be toe nailed into treated solid wood nailer the same height as insulation.
 - 5. Termination Bar:
 - a. Material: Extruded aluminum bar with lip profile.
 - b. Size: 0.090 inch thick by 3/4 inch wide with 3/16 inch lip width and a 45 degree lip angle, factory punched 1/4 inch x 3/8 inch oval holes spaced six (6) inches on center.
 - c. Approved Product/Manufacturer: "LIPTB 06" manufactured by Olympic Manufacturing Group, Inc., or approved equal.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

- A. Existing Conditions: Examine existing building and new construction to determine existing physical conditions that affect installation of new roofing.
- B. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.
- C. Environmental Requirements:
 - 1. Apply roofing in dry weather.
 - 2. Do not expose roof components and flashing in inclement weather or when it is predicted 30% or more possibility for inclement weather.
 - 3. When ambient temperature is below 40 degrees Fahrenheit, expose only enough sensitive cements, sealants, and adhesives as required for use within a four-hour period.
 - 4. Do not expose membrane and accessories to a constant temperature of 180 degrees Fahrenheit.

FULLY ADHERED THERMOPLASTIC HYBRID MEMBRANE ROOFING SYSTEM

- D. Protection:
 - 1. Provide special protection and avoid traffic on completed areas of membrane installation.
 - 2. Restore to original condition or replace work or materials damaged during handling of roof materials.
 - 3. Take precautions as required to protect adjacent work and structures.
- E. Emergency Equipment: Maintain on site equipment necessary to apply emergency temporary edge seal in event of sudden storms or inclement weather.
- F. Restrictions:
 - 1. Comply with General Requirements on use of site.
 - 2. Smoking is prohibited on all roof areas or in existing buildings.
 - 3. Maintain facility and all utility services in a functional condition.
 - 4. Provide sanitary facilities for employees.

3.2 EXAMINATION

- A. Examine and verify that receiving substrate surfaces of the structure have no defects or errors, which would result in poor or potentially defective application or cause latent defects in workmanship.
 - 1. Examine substrate to which roofing material is to be applied to ensure that its condition is satisfactory for roofing application. Do not permit voids greater than 1/4 inch wide in the substrate. Substrates for roofing materials shall be dry and free of oil, dirt, grease, sharp edges, and debris. Inspect substrates, and correct defects before application of thermoplastic sheets.
- B. Verify that roofing openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected. Starting installation shall imply acceptance of surfaces and conditions.

3.3 NAILERS

- A. Wooden nailers shall be installed at perimeter edges or drip edges on outside perimeter of building.
- B. All Construction: Nailers shall be the same height as the new insulation and recovery board being installed or to existing raised roof edge whichever is applicable. Nailers shall be anchored to resist a pullout force of 300 pounds per linear foot per Factory Mutual Data Sheet 1-49. Fasteners shall be no less than 1/2" bolts at 2'-0" on center or #12 screws at 6" on center. Provide nailers at all penetrations. Raise all curbs, flashing, etc, a minimum of eight (8) inches above the deck.

3.4 SUBSTRATE PREPARATION

- A. Substrate Surface: Prepare substrate surfaces to insure proper and adequate installation, in strict accordance with the Contract Documents and approved Shop Drawings, or manufacturer's requirements.
- B. Fill all gaps and voids between substrate components that are wider than 1/4 inch. Fill all gaps with same materials as the substrate.

- C. The membrane manufacturer shall specify types of substrates that are suitable for use with the bonding adhesive.
- D. Protection of Adjacent Areas or Surfaces: Protect adjacent areas or surfaces from damage as a result of the Work of this section. Remove sharp projections.
- E. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- F. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of the roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.5 APPLICATION OF INSULATION

- A. General:
 - 1. Manufacturer's Instructions: In regard to attachment, the manufacturer's instructions or specifications shall determine the suitability for an application.
 - 2. Precautions: The surface of the insulation must not be ruptured or damaged prior to installation of the roof membrane. Replace damaged boards.
 - 3. Thermal insulation boards shall be laid on the substrate in parallel rows with end joints staggered and butted as close as possible. All joints shall be tight and at the roof perimeter and roof penetrations, insulation shall be cut neatly and fitted to reduce openings to a minimum. All openings 1/4 inch or larger shall be filled with insulation.
 - 4. Insulation shall be tapered or feathered at drains and scuppers to provide proper drainage (if applicable).
 - 5. No more insulation shall be installed than can be covered by the completed roof system by the end of the day or the onset of inclement weather.
 - 6. Tapered insulation and crickets, when specified, shall be placed in accordance with the drawings and/or as required NRCA standards.
- B. Steel Decks: Specified rigid insulation shall be mechanically fastened to the steel deck meeting ASCE-7 wind uplift requirements as dictated by wind zone applicable to location of project. Fasteners and fastening patterns shall be determined by building height, location and geographical area of the United States. It is the contractor's responsibility to consult current publications, literature, and bulletins of current codes and the manufacturer that are in effect at the time of this project.
- C. For subsequent layer or layers of insulation or specified recovery board, the layers shall be applied using offset joints, so that all individual insulation layers joints are offset a minimum of six inches (6") both ways with the preceding layer, and immediately walked in place. Applications for adhesion are listed above.

3.6 INSTALLATION OF BASE PLY

- A. Membrane Application: Install roofing in accordance with roofing system manufacturer's current published instructions and the following requirements. Application of roofing membrane components shall immediately follow application of insulation as a continuous operation.
- B. Aesthetic Considerations: An aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this Project. Make necessary preparations, utilize

recommended application techniques, apply the specified materials and exercise care in ensuring that the finished application will be acceptable to the Owner.

- C. Adhesive Application: Apply cold adhesive with a spray equipment or squeegee or as otherwise directed by the manufacturer in a smooth even, continuous layer without breaks or voids at the rate of 1 ½ to 2 gallons per square per ply. (The porosity of some substrates may require a heavier application to ensure full adhesion. Refer to manufacturer's requirements).
- D. Bitumen Consistency: Cutting or alterations of bitumen, primer, and sealants will not be permitted.
- E. All fishmouths shall be repaired daily. Fishmouths may not be "walked-in". Fishmouths shall be cut out and replaced by the same number of plies affected. No exceptions.
- F. After completion of work, surface shall be checked for "fishmouths" or other objects causing separation between the reinforcing plies. Discrepancies shall be repaired to the Architect's acceptance. Areas indicating voids shall be cored, tested, repaired to manufacturer's acceptance. Aggregate surfacing may begin after test cuts or membrane is accepted by manufacturer and Architect. Provide copy of results from manufacturer to the Architect. This document is one of the prerequisites needed for surfacing to begin.

3.7 INSTALLATION OF THERMOPLASTIC MEMBRANE

- A. General: Install in strict accordance with manufacturer's latest published requirements, instructions, specifications, and details and approved shop drawings.
- B. Over the properly installed and prepared substrate, manufactures adhesive (Sarnacol 2121 or approved equal) shall be poured out of the pail and spread using notched ¼" X ¼" X ¼" rubber squeegees. The adhesive shall be applied at a rate according to manufacture requirements. No adhesive is applied to the back of the feltback membrane. ***Do not allow adhesive to skin over or surface-dry prior to installation of feltback membrane.***
- C. The Fleeceback roof membrane is unrolled immediately into the wet adhesive. Adjacent rolls overlap previous rolls by 3 inches. This process is repeated throughout the roof area. Immediately after application into the adhesive, each roll shall be firmly pressed into place with a water filled, foam covered lawn roller by frequent rolling in two directions. ***Do not allow adhesive to skin over or surface dry prior to installation of fleeceback membrane.***
- D. Weld cover strips at all seams that do not have a factory selvage edge.
- E. For application of hot asphalt as an adhesive for the membrane, refer to manufacturer's recommendations.

3.8 THERMOPLASTIC SEAM INSTALLATION

- A. Clean seam areas, overlap sheets, and weld side and end laps of sheets and flashings according to manufacturer's written instructions to ensure a watertight seam installation. Weld seam as follows:
 - 1. Weld Method: Hot Air
- B. Test lap edges with probe to verify seam weld continuity on a daily basis.
- C. Repair tears, voids, and lapped seams in roofing that do not meet requirements.

3.9 FLASHING INSTALLATION

- A. Install sheet flashings and performed flashing accessories and adhere to substrate according to roofing system manufacturer's written instructions.
- B. $\frac{3}{4}$ " plywood is to be used at all parapets that receive wall flashings.
- C. Apply bonding adhesive to substrate and underside of flashing sheet at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- D. Flash penetrations and field-formed inside and outside corners with sheet flashing as recommended by manufacturer.
- E. Clean seam areas, overlap seams, and firmly roll flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.
- F. Test lap edges with probe to verify seam weld continuity. Apply lap sealant, if required by roofing manufacturer, and seal exposed edges of sheet flashing terminations per manufacturer's requirements.
- G. Terminate and seal top sheet flashings and mechanically anchor to substrate through termination bars.

3.10 METAL FLASHINGS, COPINGS, EDGE TRIM AND ACCESSORIES INSTALLATION

- A. General: Secure metal flashings accessories at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

3.11 OVERNIGHT SEAL / WATER CUT-OFF

- A. Over Night Seal: Shall be performed according to accepted roofing practice as outlined in the NRCA Roofing Manual.
- B. Water Cut-Off: At the end of day's work or when precipitation is imminent, construct a water cut-off at all open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to resumption of roofing.

3.12 ROOF SYSTEM INTERFACE WITH RELATED COMPONENTS

- A. The following is a list of descriptions for correct installation of components integrated into the roof membrane assembly. In all cases, unless otherwise approved, incorporate flanged components into the system between the application of the base ply and finish ply. The flange must be primed with a uniform coating of approved ASTM D41 asphalt primer and allowed to dry thoroughly; all flanges must be set in approved mastic.
- B. Sealant: Caulk all exposed finish ply edges at gravel stops, waste stacks, pitch pans, vent stacks, etc., with a smooth continuous bead of approved sealant.
- C. Sheet Metal: Refer to Section 07 62 00, ROOF RELATED SHEET METAL.

3.13 QUALITY CONTROL

- A. Roofing Applicator: On-site evaluation welded seams shall be made by the contractor to locations as directed by the owner's representative or thermoplastic manufacturer's

FULLY ADHERED THERMOPLASTIC HYBRID MEMBRANE ROOFING SYSTEM

technical representative. Two-inch wide cross-section samples shall be taken three times a day minimum through completed seams. Correct welds shall display failure from shearing of the membrane prior to separation of weld. The contractor at no extra charge to the owner shall patch each test cut. Test seam samples shall be label with location of seam cut, date of seam cut, and retain for owner's representative or thermoplastic manufacturer's technical representative for test cut inspection.

- B. Manufacturer's Quality Control Inspection: The Manufacturer's Technical Representative shall review the on-going work as indicated in Part 1 above. All defects noted non-compliance with the specifications or the recommendations of the thermoplastic manufacturer should be itemized in a punch list. These items must be corrected immediately by the contractor to the satisfaction of the owner's representative and the thermoplastic manufacturer.

3.14 PROTECTING AND CLEANING

- A. Protect sheet membrane roofing from damage and wear during remainder of construction period.
- B. Immediately remove all spots, smears, stains, residues, adhesives, etc., from the Work of this Section and/or upon adjacent areas or surfaces, which result from the Work of this Section.
- C. Upon completion of the Work of this Section, dispose of, away from the Site, all debris, trash, containers, residue, roofing remnants and scraps which results from the Work of this Section.
- D. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair sheet flashings to a condition free of damage and deterioration at the time of Substantial Completion and according to warranty requirements.

3.15 ACCEPTANCE

- A. Prior to demobilization from the site, the owner/project manager, architect and installer shall review the work. All defects noted noncompliance with the specifications or the recommendations of the thermoplastic manufacturer should be itemized in a punch list. These items must be corrected immediately by the contractor prior to demobilization to the satisfaction of the owner/project manager, and the thermoplastic manufacturer.
- B. Notify Architect and Owner 48 hours in advance of the date and time of inspection.
- C. All warranties, as required for the project by this specification, shall be submitted for approval prior to final payment.

END OF SECTION

SECTION 07 62 00 - ROOF RELATED SHEET METAL

PART I – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. It is the intent of this Section that the Work shall:
 - 1. conform to all applicable building code requirements and of authorities having jurisdiction;
 - 2. include all shop and field formed sheet metal work shown on drawings, specified or required, including, but not limited to:
 - a. Roof penetration sleeves and hood and umbrella counterflashing
 - b. Metal counterflashing
 - c. Expansion joint
 - d. Roof drains
 - e. Scuppers
 - f. Metal perimeter edge
 - g. Gutters, Downspouts, Splash Blocks and Splash Pans
 - h. One-way roof moisture relief vents
 - i. Metal gravity vents
 - j. Metal heat exhaust vents
 - k. Sanitary vent pipes
 - l. Pipe box
 - m. Copings, trim and miscellaneous sheet metal accessories.
 - 3. be part of the Work of the Roofing System; and
 - 4. be performed by a single source contractor.

1.3 RELATED WORK

- A. Section 07 41 13 – Prefinished Metal Roofing
- B. Section 07 54 19 – Fully Adhered Thermoplastic Membrane Roofing System
- C. Section 07 72 00 – Roof Accessories
- D. Section 13 34 19 – Pre-Engineered Metal Building System
- E. All Sections of Work relating to or affecting the roofing system, including mechanical, plumbing and electrical items.

1.4 REFERENCES

- A. ASTM International (ASTM)
 - 1. A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
 - 2. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
 - 3. B32, Standard Specification for Solder Metal
 - 4. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

- B. ASCE 7
- C. Federal Specifications (FS)
 - 1. QQ-L-201 for lead
- D. National Association of Architectural Metal Manufacturers (NAAMM)
- E. National Roofing Contractors Association (NRCA)
 - 1. Roofing and Waterproofing Manual
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 1. Architectural Sheet Metal Manual
- G. ANSI / SPRI ES-1

1.5 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Shop Drawings: Indicating sizes, configurations, details of attachment to related and adjacent work, materials, and finishes.
- C. Samples:
 - 1) Full range of finish colors for Architect's selection.
 - 2) 12 inch long sample of each specified item with approved finish.
 - 3) Provide full size mockup of all shop built assemblies.
 - 4) Documentation of Wind uplift requirements for Roof Edge for specific project location
 - a. Wind Calculator available online

1.6 QUALITY ASSURANCE

- A. Single Source Responsibility: Fabricator and installer of roof-related flashing, installer of prefabricated edge metal and accessories shall be the same as the membrane roof installer.
- B. Comply with governing codes and regulations of authorities having jurisdiction.
- C. ANSI / SPRI ES-1: Install sheet metal edge flashings and copings to comply with requirements of ANSI / SPRI ES-1 / FM 1-49 for minimum of up to 150 MPH wind speed zone and wind resistance loads.

1.7 INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13, Project Coordination.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store materials in accordance with manufacturer's instructions.
- B. Handle and store materials and equipment in such a manner as to avoid damage.

- C. No storage of materials shall be permitted on roof areas other than those materials that are to be installed the same day. Any exception must be in written form. Do not place materials or equipment in such a manner as to overload structure.

1.9 WARRANTIES

- A. Manufacturer's Product Warranty:
 - 1) Manufacturer's standard 30 year Kynar 500 or Hylar 5000 Finish warranty signed by the manufacturer, with guarantee covering any failure of the fluoropolymer finish during the warranty period.
 - 2) Failure is defined to include, but not be limited to:
 - a. Deterioration of finish, such as fading, discoloring, peeling, cracking, corroding, etc.
 - 3) Wind Warranty
 - a. Non Coastal: up to 160 MPH Blow Off Resistance, 20 Year
 - b. Coastal: 215 MPH, Lifetime of Roof installed on
 - 4) Correction may include repair or replacement of failed product as outlined in Warranty Documents
 - 5) Finish warranty and wind warranty shall be delivered by Roofing Contractor to Owner at the conclusion of project as part of project closeout documents.
- B. Roofing Contractor's Warranty:
 - 1. Contractor shall warrant the installation and related work to be free from defects in workmanship and materials, and that the metal flashings will be and remain watertight and secure, for a period of five (5) years from date of Substantial Completion.
 - 2. Defects shall include, but not be limited to:
 - a. Leaking water on the exterior of the building, causing staining or discoloration of wall/exterior surface.
 - b. Leaking water or bitumen within building or construction.
 - c. Becoming loose from substrate/blocking.
 - d. Loose or missing parts.
 - e. Finish failure as defined above.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Metal Era, Inc., which is located at: 1600 Airport Rd.; Waukesha, WI 53188; Toll Free Tel: 800-558-2162; Tel: 262-549-6900; Fax: 800-373-9156; Email:request_info@metalera.com; Web:www.metalera.com
- B. Substitutions: Before proposal date upon roof consultant approval.
- C. Manufacturers named within specification are approved for use on the Project providing:
 - 1. their products meet or exceed the specifications;
 - 2. company has a minimum of five (5) years' experience manufacturing products of the type specified;
 - 3. products have been tested in conjunction with roofing membrane system as an assembly and as such has obtained the same approval and rating as the roofing membrane system; and
 - 4. products are approved for use by the roofing membrane manufacturer.

2.2 SHEET METAL MATERIALS

- A. General Requirements: Roofing sheet metal system shall have been tested in conjunction with roofing membrane system as an assembly and have the same approval and rating as the roofing membrane system.
- B. Prefinished Galvanized Sheet Steel:
 - 1. Commercial quality ASTM A527 G-90 hot-dip galvanized coating designation.
 - 2. Thickness: Except as otherwise indicated, minimum 24 gauge. SMACNA recommendations shall govern.
 - 3. Finish: Kynar 500 or Hylar 5000 in color as selected by Architect from manufacturer's [custom] colors.
- C. Membrane Clad Sheet Steel:
 - 1. Commercial quality ASTM A527 with G-90 hot-dip galvanized coating designation.
 - 2. Thickness: Except as otherwise indicated, minimum 24 gauge. SMACNA recommendations shall govern.
 - 3. Finish: PVC / TPO coating as per Membrane Manufacturer's requirements.
- D. Prefinished Aluminum Sheet:
 - 1. Precoated type, aluminum conforming to Fed. Spec. QQ-A-250, ASTM B209.
 - 2. Finish: Kynar 500, color as selected by Architect from manufacturer's [custom] colors.
 - 3. Thickness: Minimum 0.040 inch, except as otherwise indicated.
- E. Sheet Lead:
 - 1. Comply with FS QQ-L-201, Grade B
 - a. Four (4) pound minimum for use at roof drains and soil stacks.
- F. Stainless Steel: ASTM A167, Type 302 / 304 Soft Temper, No. 2D finish. Minimum thickness 24 gauge, except as otherwise noted.

2.3 FASTENERS

- A. Same metal as flashing / sheet metal or other non-corrosive metal or as noted below.
- B. Exposed fasteners shall be self-sealing and gasketed (ZAC type) for weathertight installation.
- C. Match finish of exposed heads with material being fastened.
- D. Mechanical Fasteners:
 - 1. Nails: Ring shank, minimum 1-1/2 inches in length with 1/2 inch diameter head.
 - 2. Washers: Steel washers with bonded rubber sealing gasket.
 - 3. Screws: Self-tapping sheet metal type of stainless steel or compatible with material being fastened, with hooded integral EPDM washers (ZAC type).
 - 4. Rivets: Stainless steel and cadmium plated material, closed end type of sizes recommended by sheet metal manufacturer to suit application.
- E. Clips:
 - 1. Cleat (coping / fascia): Minimum 22 gauge, G-90 galvanized, stainless steel, or aluminum. Match material of coping / fascia and provide one (1) gauge heavier.

2.4 RELATED MATERIALS

- A. Solder: ASTM B32, alloy grade 58, 50 percent tin, 50 percent lead.
- B. Flux:
 - 1. Phosphoric acid type, manufacturer's standard.
 - a. For Use with Steel or Copper: Rosin flux
 - b. For Use with Stainless Steel: Acid-chloride type flux, except use rosin flux over tinned surfaces.
- C. Underlayment:
 - 1. At expansion joints: to be used as bellow; 48 mil minimum, non-reinforced, homogeneous, waterproof, impermeable elastomeric sheeting manufactured by Nervastral, Inc. or Lexsuco.
 - 2. At wood blockings: Self-Adhered Flexible Flashing: 40-mil, rubberized asphalt adhesive reinforced flashing with a high density cross laminated polyethylene film. Provide compatible substrate primer as instructed by manufacturer and coordinate with specification 07 65 00.
- D. Adhesives: Type recommended by flashing sheet manufacturer seaming and adhesive application of flashing sheet to ensure adhesion and watertightness.
- E. Metal Accessories: Sheet metal clips, straps, anchoring devices, clamps and similar accessories required for the complete installation of work, matching or compatible with material being installed, non-corrosive, size and gauge recommended by installer to suit application and performance.
- F. Sealant:
 - 1. Type A:
 - a. Type: One-part, non-sag, moisture-curing polyurethane sealant.
 - b. Approved Products / Manufacturers: "Chem-Calk 900" manufactured by Bostik Construction Products Division, "Vulkem 921" manufactured by Mameco International, Inc., "Dynatrol I" manufactured by Pecora Corporation, "MasterSeal NP 1" manufactured by BASF, or approved equal.
 - 2. Type B:
 - a. Type: One-part, neutral-curing, medium-modulus silicone sealant for sealing metal to metal surfaces, i.e. metal edge, cover plates, etc.
 - b. Approved Products / Manufacturers: "Chem-Calk 1200" manufactured by Bostik Construction Products Division, "795 Silicone Building Sealant" manufactured by Dow Corning Corporation, "895 Silicone" manufactured by Pecora Corporation, "Omniseal" manufactured by Sonneborn Building Products, "Spectrem 2" manufactured by Tremco Incorporated, or approved equal.
- G. Grout - Pitch Pans:
 - 1. Type: Quick-setting, non-shrink, non-metallic, high strength formula complying with ASTM C1107.
 - 2. Approved Products / Manufacturers: "Sure Grip High Performance Grout" manufactured by Dayton Superior Corporation, "Premier Quick-Trim" manufactured by L & M Construction Chemicals, Inc., "MasterFlow" manufactured by BASF, or approved equal.
- H. Pitch Pan Filler:
 - 1. Type: Pourable polyurethane sealer, approved by roofing system manufacturer.

2. Approved Products / Manufacturers: "Quick Pitch Sealer" manufactured by U.S. Intec, "SPM Pourable Sealer" manufactured by Johns Manville, or approved equal.
- I. Termination Bar:
 1. Material: Stainless steel or extruded aluminum bar with lipped profile.
 2. Size: 1/8 inch thick by one (1) inch wide with factory punched 1/4 inch x 3/8 inch oval holes spaced six (6) inches on center.
 3. Approved Product / Manufacturer: "TB 125" manufactured by TruFast Corp., or approved equal.
- J. Pipe Hangers and Supports: Refer to Section 07 72 00, Roof Accessories.
- K. Splash Blocks: Concrete type, of size and profiles indicated; minimum 3,000 psi compressive strength at 28 days, with minimum five (5) percent air entrainment. Use at locations where roof drainage discharges on ground.
- L. Splash Pans: 22 gauge stainless steel, of size and profiles indicated. Use at locations where roof drainage discharges over adjoining, lower roof level(s).

2.5 FABRICATION

- A. Except as otherwise indicated, fabricate work in accordance with SMACNA Architectural Sheet Metal Manual and other recognized industry practices and reviewed shop drawings. Form all flashings, receivers and counterflashings in accordance with standards set forth in the NRCA roofing manual and SMACNA.
- B. Comply with manufacturer's installation instructions and recommendations.
- C. Shop fabricate Thru-wall, counterflashings, expansion joint metal and wind clips to greatest extent possible.
- D. Fabricate items to size and dimensions as indicated on the drawings. Limit single-piece lengths to twelve (12) feet for prefabricated pieces and ten (10) feet for shop fabricated pieces.
- E. Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work sufficient to permanently prevent leakage, damage or deterioration of the work.
- F. Integrate flashing in a manner consistent with membrane waterproofing detailing. Form work to fit substrates.
- G. Make angle bends and folds for interlocking metal with full regard for expansion and contraction to avoid buckling or fullness in metal after installation.
- H. Fabricated items will have straight lines, sharp angles, smooth curves, and true levels. Avoid tool marks, buckling, and oil canning.
- I. Fold back edges on concealed side of exposed edge to form hem.
- J. Unless noted otherwise, lap joints minimum three (3) inch. Lap joints to have sealant installed as per details, to maintain watertight condition, inside and outside corners and elevation changes to be riveted and soldered.

- K. Seams:
 - 1. Wherever possible, fabricate non-moving seams in sheet metal with flat-lock seams and end joints.
 - 2. Pre-finished Galvanized Steel: Seal pre-finished metal seams with rivets and silicone sealant.
 - 3. Metal Other than Aluminum: Tin edges to be seamed, form seams, and solder.
- L. On Kynar 500 or Hylar 5000 pre-finished metal, surface sand metal flanges prior to applying any primers. Prime all metal in contact with bituminous material.
- M. Backpaint all concealed metal surfaces with bituminous paint where expected to be in contact with cementitious materials or dissimilar metals.
- N. Expansion Provisions: Where lapped or bayonet type expansion provisions in work cannot be used or would not be sufficiently waterproof or weatherproof, form expansion joints of intermeshing hooked flanges, not less than one (1) inch deep filled with mastic sealant concealed within joints.

2.6 FABRICATED ITEMS

- A. Metal Flashings:
 - 1. Through Wall Receiver Tray: Minimum 24 gauge stainless steel formed in maximum ten (10) foot lengths, through wall receivers shall not extend past the face of the exterior veneer more than $\frac{3}{4}$ ".
 - 2. Counterflashings: Minimum 24 gauge stainless steel, 24 gauge prefinished steel, formed in maximum ten (10) foot lengths.
- B. Wind Clips: Minimum 24 gauge stainless steel (or match material of counterflashing), one (1) inch wide by length to engage counterflashing a minimum of 1/2 inch. To be installed at all wall flashings and at curb flashing lengths longer than 5 feet.
- C. Roof Penetrations:
 - 1. Umbrella Counterflashing: Two-piece construction of minimum 22 gauge stainless steel, fabricated in accordance with drawings or project requirements.
 - 2. Flashing Pans:
 - a. 24 gauge stainless steel.
 - b. Fabricate to provide installed minimum clear inside perimeter dimension of two (2) inches on each side of penetrating element.
 - c. Fabricate pans to at least six (6) inches above the finished roof membrane and with 1/4 inch hem at top edge and with four (4) inch flanges. Round all corners of flange.
 - d. Fabricate metal bonnets for all pans, NO EXCEPTIONS. Fabricate bonnets with metal compatible with metal to which bonnet is to be attached. On beams and other steel, weld in place bonnets fabricated from 1/4 inch steel plate. Draw band bonnets fabricated from 22 gauge stainless steel may be used on circular projections.
- D. Metal Edge / Fascia:
 - 1. Perma-Tite System 200 Fascia for thermoplastic roof systems: Decorative metal fascia with continuous formed rail.
 - 1) Construction:
 - a) Fascia metal gauge
 - 1) .040 inch (1 mm) thick formed aluminum.
 - b) Finish:
 - 1) Kynar-500 color as selected by the Architect from roof

- edge manufacturer's [full range of] [standard] [custom] colors.
 - c) Formed Rail: Shall be continuous 20 gauge galvanized steel at 12'-0" standard lengths with pre-punched slotted holes and 6" stainless steel springs at 4'-0" on center.
 - 2) Thermoplastic Version
 - a) Model:
 - 1) FA-80 (8.25" Face)
 - b) Performance:
 - 1) 20 year, 160 mph Wind Warranty.
 - 2) Tested per ANSI / SPRI ES-1 FM 4435 Standard to a design pressure of 200 psf to comply with the International Building Code.
 - 3) FM tested to a minimum FM 1-180 rating
- E. Metal Coping
- 1. Perma-Tite Coping
 - 1) Construction:
 - a) Metal:
 - 1) .040 inch (1.01 mm) aluminum.
 - b) Finish:
 - 1) Kynar-500 color as selected by the Architect from roof edge manufacturer's custom colors.
 - 2) Coping Cap: Length of 12'-0", widths to 24" manufactured to job requirements. True radii may be built to template.
 - 3) Coping Vertical Face and Back Leg: 2 1/4" to 12 1/2" manufactured to job requirements.
 - 4) Concealed Splice Plates: 8" wide. Finish to match finish of coping cap with factory applied dual non-curing sealant strips.
 - 5) Anchor / Support Cleat: 20 gauge pre-punched galvanized cleat with stainless steel spring mechanically locked to cleat normally 12" wide at 4'-0" on center. Mechanically fastened as indicated and detailed.
 - 6) Fasteners: 1 1/2" stainless steel with driver.
 - 7) Performance:
 - a) 20 Year, 160 mph Wind Warranty
 - b) Tested per ANSI / SPRI ES-1 / FM4435 Standard to comply with the International Building Code.
 - c) Miami-Dade Approved (No. 13-0419.03 12/11/18) to comply with the "High Velocity Hurricane Zone of the Florida Building Code".
- F. Continuous Cleats (where applicable): Continuous strips, same material and profile, minimum one gauge heavier of item which cleats attach.
- G. Vent Hoods, Sleeves, Penetration Flashings, and Accessories: Minimum 24 gauge stainless steel, or as shown or directed otherwise.
- H. Angle Termination Bar: Aluminum pressure bar 1/8 inch x one (1) inch.
- I. Vent Pipe Flashing: Four (4) pound lead. Provide proper size to fold down inside of pipe a minimum of one (1) inch.
- J. Gutters / Downspouts / Collector Heads: Seal-Tite Industrial Gutter System by manufacturer.
- 1. Minimum 0.040 inch thick pre-finished aluminum, formed in maximum twelve (12) foot lengths.
 - 2. Verify gutter and downspout meets rainfall data as outlined in SMACNA.

3. Seal-Tite Industrial Gutter, including 2" Wide Gutter Straps 24" o.c., Wind Straps 6'-0" o.c., 1/8" Stainless Steel Pop Rivets, and #10 x 2" Stainless Steel Fasteners to be manufactured and supplied to suit profile and dimension of gutter and downspout by manufacturer.
4. .040" Aluminum, 24 gauge galvanized steel, color to match gutter.
5. For Single Ply roofing systems: Drip Edge with Factory Applied Flashing (TPO or PVC).
6. 24 gauge galvanized steel with membrane manufacturer's coating.
7. End Caps, Downspout Outlets, Gutter and Downspout Straps, Support Brackets and joint fasteners to be manufactured to suit profile and dimension of gutter and downspout.
8. Install all anchoring devices as outlined in manufacturer literature.
9. Expansion Joints: Style 1 per manufacturer, locate every 50 linear feet.
10. Gutter Straps and Supports: Minimum 3 .100 inch thick Downspout straps: Strap type, like metal, match color.
11. Downspout straps: Strap type, like metal, match color.
12. Gutter Screen: .050" Aluminum with 1/4" dia. perforations
13. Collect Heads: Minimum 0.040 inch thick pre-finished (match color) aluminum. As outlined in SMACNA; Refer to Figure 1-25F and Figure 1-28 with alternate Section A-A.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify substrates are smooth and clean to extent required to perform sheet metal work.
- B. Verify roof openings, curbs, pipes, sleeves, ducts or vents through roof are solidly set in place.
- C. Verify that reglets, nailers, cants, and blocking to receive sheet metal are in place and free of concrete and soil.
- D. Do not start work until conditions are satisfactory.

3.2 PREPARATION

- A. Field measure site conditions prior to fabrication work.
- B. Install starter and edge strips and cleats before starting installation.

3.3 INSTALLATION

- A. Install sheet metal with lines, arises, and angles sharp and true, and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form 1/4 inch hem on concealed side from view. Finished work shall be free from water retention and leakage under all weather conditions. Pre-fabricated corners or transitions are required at changes in direction, elevation, or plane and at intersections. Locate field joints not less than 12 inches, nor more than three (3) feet from actual corner. Laps shall be one (1) inch, riveted and soldered at following locations:
 1. Pre-fabricated corners;
 2. transitions;
 3. changes in direction, elevation, and plane; and
 4. at intersections.

- B. Anchor units of work securely in place to prevent damage or distortion from wind or buckling. Provide for thermal expansion of metal units; conceal fasteners wherever possible; and set units true to line and level as indicated. Install work with laps, joints, and seams which are permanently watertight and weatherproof.
- C. Install fabricated sheet metal items in accordance with manufacturer's installation instructions and recommendations and with SMACNA Architectural Sheet Metal Manual.
 - 1. Ensure approved fasteners are used throughout the project.
 - 2. Ensure fasteners are installed in manufacturer pre-punched holes on rails, extrusions, clips and cleats.
 - 3. Ensure sufficient amount of waterblock is applied where appropriate to prevent leaking under rails/extrusions. **Contractor is responsible for cleaning stained brick and remedying for total length of workmanship warranty if waterblock is not installed appropriately.**
- D. Separations: Provide for separation of metal from dissimilar metal or corrosive substrates by coating concealed surfaces with zinc chromate, bituminous coating, or other permanent separation at locations of contact as recommended by manufacturer or fabricator. Do not use materials which are incompatible with roofing system.
- E. Cleat: At exposed edges of perimeter edge, fascias, cap flashings, and where required, attach cleat with appropriate fasteners supplied by roof edge manufacturer. Install cleat so fascia extends a minimum of 1 inch below top of exterior wall finish.
- F. Counterflashing:
 - 1. Do not use surface mount counterflashing except as noted in drawings.
 - 2. Set in through wall with receiver and spring lock counterflashing, as detailed in drawings and to NRCA roofing manual, SMACNA standards.
 - 3. Coordinate installation of through-wall flashing with the masonry contractor.
 - 4. Seal through-wall in conjunction with masonry wall waterproofing.
 - 5. Install wind clips 30 inches o.c. at all counterflashing over five (5) feet in length.
- G. Pitch Pans, Metal Flanges:
 - 1. Apply mastic under pitch pan or metal flashing flange at least 1/2 pound per linear foot.
 - 2. Prime all metal flanges with asphalt primer prior to flashing installation.
 - 3. Clean all projections enclosed in pitch pans in any manner suitable and coated with a rust inhibitive coating as approved by the Architect. Coating shall be allowed to dry prior to pitch pan fill.
 - 4. Fill base of pitch pans with grout or cementitious binder and allow to cure.
 - 5. Top Finish Fill: Self-leveling, one-part urethane; at least two (2) inches to top of pitch pan sides.
 - 6. Strip in pitch pan flanges with two strips of specified stripping plies set in hot bitumen extending three (3) inches from the outer edge of the flange to at least three (3) inches inward toward base of pitch pan. Provide finish stripping ply of SBS modified bitumen membrane in hot bitumen extending six (6) inches from the outer edge of the flange and butt to base of pitch pan.
- H. Sanitary Vent Stacks:
 - 1. Prime top and bottom flanges of lead flashing sleeve. Set flange in uniform troweling of plastic roof cement. Prime top side of flange to receive strip-in membrane.
 - 2. Fold lead sleeve down inside of pipe a minimum of one (1) inch. Apply a continuous bead of sealant on inside of pipe prior to folding lead sleeve.

- I. Gutters / Downspouts:
 1. Install gutters as detailed.
 2. Install downspouts plumb and level, attached to columns or wall with straps located at top and bottom of downspout and maximum ten (3) feet on center (note: 3 per 12' lengths supplied by manufacturer.
 3. Install splash pad or block under discharge port of downspouts (if non exist). Install splash pan over a protection (walkway) pad for downspouts located at roof level.

3.4 CLEANING AND PROTECTION

- A. Remove flux and residual acid immediately by neutralizing with baking soda and washing with clean water. Leave work clean of stains.
- B. Remove scraps and debris and leave work area clean.
- C. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes. Paint areas where finish is damaged on pre-finished metal by painting with a compatible paint in color to match undamaged finish.
- D. Prime soldered area of phosphatized metal after cleaning to prevent rusting.
- E. Paint metal flashings that have been soiled with bitumen with aluminized paint.
- F. Clean other work damaged or soiled by Work of this Section.
- G. Protect finished work from damage.

END OF SECTION 07 62 00

SECTION 07 65 00 - FLEXIBLE FLASHING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- B. Provide flexible flashing where shown on drawings or required.

1.3 RELATED SECTIONS

- A. Section 04 20 00 – Unit Masonry
- B. Section 07 27 26 – Fluid Applied Air Barrier System
- C. Section 07 54 23 – Fully Adhered Thermoplastic Membrane Roofing System

1.4 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Certification: Manufacturer's affidavit that materials used in Project contain no asbestos.
- C. Compatibility: Submit letter from primary Fluid Applied Air Barrier System Manufacturer stating that materials proposed for use are permanently chemically compatible and adhesively compatible with adjacent materials proposed for use. Submit letter from Manufacturer stating that cleaning materials used during installation are chemically compatible with adjacent materials proposed for use.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Manufacturers listed whose products meet or exceed the specifications are approved for use on the Project. Flexible flashing materials used shall be compatible with and not void any warranties of the air barrier system used. Other manufacturers must have a minimum of five (5) years' experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.

2.2 MATERIALS

- A. Flashing:
 - 1. Copper Laminated Flashing:
 - a. Flashing: A full sheet of copper weighing five (5) ounces per square foot coated or bonded on both sides with one (1) of the following:
 - 1) Modified asphalt compound coated.
 - 2) Asphalt saturated, waterproof glass fiber laminated fabric.
 - b. Approved Manufacturers:
 - 1) Advanced Building Products, Inc.
 - 2) Hohmann & Barnard, Inc.

- 3) Sandell Manufacturing Company, Inc.
 - 4) York Manufacturing, Inc.
 - c. Mastic: Manufacturer recommended asphalt troweled mastic for sealing copper laminated flashings
2. Asphalt-free Copper Fabric Flashing (Contractor's Option – in lieu of item above):
 - a. Glass fabric scrim bonded to a full sheet of copper for general thru-wall flashing as an alternative to asphalt coated copper specified above and where sealant compatibility is required. Provide manufacturers approved seam tape.
 - b. Approved Product/Manufacturer: Multi-flash 500 as manufactured by York Manufacturing, Inc.; or Copper-Tuff as manufactured by Hohmann & Barnard, Inc. (No substitutions)
3. Membrane Flashing:
 - a. Self-Adhered Flexible Flashing: 40-mil, rubberized asphalt adhesive reinforced flashing with a high density cross laminated polyethylene film. Provide compatible substrate primer as instructed by manufacturer.
 - b. Approved Products / Manufacturers:
 - 1) "TW-Thru Wall Flashing" manufactured by Tamko Waterproofing.
 - 2) "Perm-A-Barrier" manufactured by W. R. Grace & Co.
 - 3) "Blueskin TWF" manufactured by Henry Co.
 - 4) "Bitu-Rap" manufactured by Nervastral, Inc.
 - 5) "Air-Shield" manufactured by W.R. Meadows, Inc.
 - 6) "AquaFlash 500" manufactured by Fiberweb.
4. Substrate Primer: as instructed by membrane manufacturer
5. Termination Bar: 1/8 inch thick by 1 inch minimum wide stainless steel, w/ pre-punched holes and self-tapping screws.
6. Weathering Flange at Door / Window Openings: Provide a 20 gauge (0.040") stainless steel or .040 aluminum 2"x3" weathering flange at head, jamb and under sill pan of storefront window and hollow metal door systems. Screw into wood blockings or substrate walls and strip into air barrier system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Flashing:
 1. Follow manufacturer's instructions for mechanically fastened installation with a termination bar.
 2. Application Guidelines - Install flashing at the following locations:
 - a. Membrane Flashing: material transitions inside exterior cavity walls, roof edge / exterior wall transitions, masonry joints (control/expansion) inside exterior cavity walls, exterior door and window frame perimeters, roof deck / exterior wall transitions, exterior wall penetrations (i.e. pipe, conduit, ducts, etc.). Provide membrane at all joints, holes, gaps, or openings to ensure a continuously sealed building envelope. Utilize primer on substrates as instructed by manufacturer.
 - b. Copper Flashing: At all horizontal wall flashing, including (but not limited to) exterior wall sill / weep conditions, exterior door and window head / weep conditions, intermediate and / or shelf angles, masonry wall cap flashing and masonry wall base flashing.
 3. Apply substrate primer as instructed by membrane manufacturer to suit condition.

4. Provide drip edge flashing at weep conditions with membrane flashing. Cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind with outside edge of brick over top of drip edge flashing to alleviate exposure to UV degradation and deterioration of asphalt membrane.
5. On Horizontal Surfaces: The flashing shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. The flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall, turned up where possible to facilitate drainage through the weepholes, then carried upward across the cavity a minimum of six (6) inches. Flashing will then be secured in back wall with termination bar.
6. On Vertical Surfaces: Surfaces receiving the flashing shall be sufficiently spotted with asphalt mastic to hold in place until masonry is set. Secure in back wall with termination bar.
7. Foundation Sill Dampproofing: The flashing for foundation sills shall be laid in a slurry of fresh mortar or in a full bed of mastic and topped with a fresh full bed of mortar. The flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be sloped across the cavity and turned up the wall a minimum of ten (10) inches and secured to back wall with termination bar. Where sill and column meet, flashing shall be brought up a minimum of ten (10) inches up the column.
8. Thru-Wall Flashing: Shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Carry flashing through the wall, turned up where possible to facilitate drainage through the weepholes, then carried upward across the cavity a minimum of six (6) inches, unless noted otherwise, and secure in back wall with termination bar.
9. Cavity Wall: Flashing shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. Flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall and upward across the cavity a minimum of six (6) inches, unless noted otherwise, and secured in the back wall with termination bar. Vertical membrane joints shall be secured with termination bar as instructed by membrane manufacturer.
10. Heads, Jambs and Sills: Flashing for heads and sills shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall and upward across the cavity a minimum of six (6) inches, unless noted otherwise. Head flashing shall be carried six (6) inches beyond both end of the steel lintel. Both head and sill flashing shall be turned up at the sides to form a pan. All corners shall be folded, NOT CUT. Jambs are to be turned into the buildings to complete seal perimeter of window or door. Install weepholes.
11. Wood blockings: Flexible flashings are to cover wood blockings in their entirety.
12. Spandrels: Spandrel flashing shall start from the outside toe of the shelf angle, go up the face of the beam and then through the wall, turned up on the inside not less than two (2) inches. Install weepholes.
13. Parapet or Coping: Flashing for parapets or coping sills shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. Flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Weepholes shall be installed immediately on top of the flashing.
14. Lengths: Install flashings without longitudinal joints within walls, if possible. If required materials are not available in a single width, join by lapping material minimum two (2) inches and seal joint throughout its length with adhesive.
15. End Joints: Avoid end joints in flashing. When end joints are necessary, lap flashing minimum six (6) inches and seal joint continuously with adhesive.
16. Penetrations: Where anchors, pipes, and inserts penetrate flashing, make opening in flashing snug and seal with adhesive.
17. Reglet Termination: Insert wedge into place and seal carefully with adhesive.

- 18. Termination Bar: Install flashing with termination bars in accordance with manufacturer's instructions. Provide 3 coursing at all termination bars, typical.
 - 19. Top Coat: After flashing material is in place (except in masonry joints where bond and mortar is required) trowel full 1/8 inch protective coating or mastic on all flashing faces.
- B. Bed Joints: Coordinate work with Division 4, Masonry. Install thru-wall flashings between two (2) thin layers of masonry mortar without increasing thickness of mortar joint. Keep outer edge of flashing material back 3/4 inch from face of masonry.

3.2 APPLICATION

- A. Protect membrane from overexposure to direct sunlight.
- B. Follow manufacturer's recommendations for installation.
- C. Adjacent Work: Protect work by masking, covering, or other precautionary methods. Remove protection when no longer necessary.

END OF SECTION 07 65 00

SECTION 07 22 00 - ROOF ACCESSORIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 INSTALLATION RESPONSIBILITY

- A. In addition to the items normally a part of this Section, coordinate the installation of roof accessory curbs and pipe flashings and equipment supports that may be specified elsewhere.
- B. Coordinate the Work specified herein with the following Work:
 - 1. Roofing
 - 2. Roofing sheet metal
 - 3. Mechanical equipment
 - 4. Plumbing

1.3 REFERENCES

- A. Federal Specifications (FS)
 - 1. TT-S-00227E
- B. National Roofing Contractors Association (NRCA)
- C. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 1. Architectural Sheet Metal Manual

1.4 SUBMITTALS

- A. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
- B. Shop Drawings: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.

1.5 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination.

1.6 WARRANTY

- A. Warranty the Work specified herein for one (1) year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Noticeable deterioration of finish
 - 2. Leakage of water into the building or within the construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Specifications are based on products of named manufacturers. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.

2.2 PREFABRICATED ROOF CURBS

- A. Frames:
1. Material: ASTM A 653 G90 hot-dipped galvanized steel.
 - a. Minimum 18 gauge, and as engineered by manufacturer.
 - b. Minimum 18 gauge for curbs supporting HVAC units
 - c. Minimum 20 gauge for expansion joint curbs.
 2. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections not accepted.
 3. Base Plates: Integral to frame and welded.
 4. Internally reinforced with galvanized 1 inch by 1 inch by 12 gauge angles for curbs exceeding 3 foot length. Reinforce internal bulkhead at equipment curbs to support lateral loads.
 5. Wood Nailers: Factory installed, pressure treated. Size and width as suitable for support of items installed on curbs.
- B. Insulation: Factory installed 1-1/2 inch thick three-pound density fiberglass insulation.
- C. Curb Height: Minimum 8 inch above finished roof.
- D. Construct curbs to match roof slope with plumb and level top surface for mounting mechanical equipment.
- E. Gasketing: 1/4 inch thick, one (1) inch wide at roof top units.
- F. Counterflashing: 24 gauge stainless steel
- G. Counterflashing Cap: Stainless steel.
- H. Cants:
1. Non-canted curb style installs either under or on top of metal decks with insulation.
 2. Cants shall be provided under Section 07 52 19 - Roofing
- I. All insulated roof curbs shall be structural and shall include calculations signed and sealed by a registered Structural Engineer. Refer to installation drawings for any additional structural requirements. If curbs do not span a minimum of two bar joists, only two angles will be required. Coordination mechanical equipment weight loading on the roof with Structural Engineer.
- J. Approved Manufacturers:
1. Custom Curb, Inc.
 2. Roof Products, Inc.

2.3 PIPE SUPPORTS (Cannot be contractor built supports)

- A. Gas Pipe Supports:
 - 1. Provide strut and hanger type support with recycled plastics and carbon black for UV protection bases (10 inches x 16 inches x 3 inches; 6 lbs. each); Model Type PP-10 with strut & hanger for lines 2-1/2 inches and smaller, Model Type PS-1-2 with hanger for lines 3 inches and larger.
 - 2. As manufactured by PHP Systems Design; Miro Industries Inc.; MAPA Products; Advanced Support Products or Architect approved equal.
- B. Electrical Conduit / Condensate Lines:
 - 1. Provide strut type support with recycled plastics and carbon black for UV protection bases (10 inches x 16 inches x 3 inches; 6 lbs. each), install with hold clips ordered as an accessory; Model Type PP-10 with strut. Model Type PS-1-2 with hanger for lines 3 inches and larger.
 - 2. As manufactured by PHP Systems Design; Miro Industries Inc.; MAPA Products; Advanced Support Products or Architect approved equal.
- C. Chill Water Lines:
 - 1. Provide strut and hanger type support with recycled plastics and carbon black for UV protection bases (size as required); Model Type PS-1-2 and Model Type PSE-2-2 as required.
 - 2. As manufactured by PHP Systems Design, Inc.; Miro Industries Inc.; MAPA Products; Advanced Support Products or Architect approved equal.
- D. Installation:
 - 1. Locate as indicated by Drawing at no greater than 8 feet-0 inches o.c.
 - 2. Provide protective traffic pads below each support, tacked in place with approved mastic or adhesive.
 - 3. Install hold down clips if indicated on the drawings or required.

2.4 ROOF TO ROOF EXPANSION JOINT

- A. Stainless Steel expansion joint covers on new wood curbs, as detailed on drawings and outlined the NRCA and SMACNA manual.

2.5 ROOF DRAIN / DOWNSPOUT WALL NOZZLE

- A. Downspout Wall Nozzle at Concealed Roof Drain Leader / Discharge: Josam 25010 Series cast bronze Downspout Nozzle with loose flange and inlet threaded connection or Architect approved equal. Diameter appropriate to downspout size.

2.6 PLUMBING PEDESTAL HYDRANT

- A. Provide freeze-proof pedestal hose station / hydrant with stainless steel shroud, welded stainless steel flange, black powder coated cast aluminum dome handle, mail hose fitting and vacuum breaker. Provide powder coated under-deck support flange with hardware. Provide for dissimilar metal protection.
- B. As manufactured by MAPA Products Model MPH-24D:24/9 Pedestal Hydrant as required for condition or Architect approved equal.

2.7 ELECTRICAL PEDESTAL DISCONNECT / OUTLET

- A. Provide rain-proof pedestal disconnect with stainless steel square tubing and welded stainless steel flange. Provide powder coated under-deck support flange with hardware. Provide for dissimilar metal protection.
- B. As manufactured by MAPA Products Model MPD-(XX) Pedestal Disconnect as required for condition or Architect approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof accessories in accordance with manufacturer's printed instructions and approved shop drawings. Installation of Portable Pipe Hangers shall not exceed six (6) feet on center.
- B. Coordinate with roofing operation for watertight integrity.
- C. Finished installation shall be water and air tight. Install sealant conforming to FS TT-S-00227E, Type II, Class A.

END OF SECTION 07 72 00

SECTION 07 22 33 - ROOF SCUTTLE (HATCHES)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 RELATED WORK

- A. Section 03 32 16- Lightweight Insulating Concrete Deck System
- B. Section 05 31 00 - Metal Deck
- C. Section 05 50 00 - Miscellaneous Metals
- D. Section 06 10 00 - Rough Carpentry
- E. Section 07 54 23 – Fully Adhered Thermoplastic Membrane Roofing System

1.3 SUBMITTALS

- A. Product Data: Submit schedules, charts, literature and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
- B. Shop Drawings: Include materials, opening sizes, fabrication details, hardware, attachments, related and adjacent work, and finishes.

1.4 WARRANTY

- A. Warrant the work specified herein for five (5) years, against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Faulty, improper or inadequate attachment or installation.
 - 2. Difficult or noisy operation.
 - 3. Noticeable deterioration of finish.
 - 4. Leakage of water into the building or within the construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Specifications are based on products manufactured by The Bilco Company.
- B. Manufacturers listed below whose products are equivalent to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions to be considered.
 - 1. Acudor Products Inc.
 - 2. Babcock-Davis Hatchways, Inc.
 - 3. Dur-Red Products
 - 4. J. L. Industries, Inc.

5. Karp Associates, Inc.
6. Nystrom Building Products

2.2 ROOF SCUTTLES (HATCHES)

- A. Size: 2 feet-6 inches x 3 feet-0 inches, unless shown otherwise.
- B. Thermally Broken Cover: Shall be 11 gauge aluminum with 3" concealed polyisocyanurate insulation, 5" beaded, overlapping flange, fully welded at corners, and internally reinforced for 40 psf live load., fully covered and protected by an aluminum liner.
- C. Thermally Broken Curb: Shall be 12 inches in height and of 11 gauge aluminum. It shall be formed with a 5-1/2 inch flange with holes provided for securing to the roof deck. Curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, full welded at the corners for weathertightness. Capflashing shall be equipped with the Bilclip™ flashing system, including stamped tabs and Pak-Rope. Insulation on the exterior of the curb shall be rigid fiber board one (3) inches in thickness.
- D. Thermally Broken Scuttle (Hatch): Shall be completely assembled with heavy pintle hinges, positive snap latch with turn handles, padlock hasps inside and outside, and a mechanically retained thermoplastic rubber gasket. Compression spring operators enclosed in telescopic tubes shall be provided for smooth, easy and controlled door operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature. Cover shall be equipped with an automatic hold-open arm complete with red vinyl grip handle to permit easy release and one-hand control of the cover to its closed and latched position. All hardware shall be stainless steel. Scuttle factory finish shall be mill finish aluminum.
- E. Approved Model / Manufacturer: Type No. "S-50" Roof Scuttles (Hatches) for ladder access, or Architect approved equal.
- F. Ladder: As specified in Section 05 50 00, Miscellaneous Metals. Ladder shall be oriented and mounted along the short dimension of the hatch.
- G. Fall Protection Safety Rail and Ladder Extension: 30"x36" Model SP-3036 Made by **SafePro L.C.**
- H. Folding Fall Protection Safety Rail and Ladder Extension: Folding aluminum guard rail system 30"x36" Model by Precision Ladders LLC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Roof hatches and heat / smoke vents shall be welded to structural steel frame of building.
- B. Install hatches and heat / smoke vents in accordance with details on drawings, approved shop drawings, and manufacturer's instructions.

END OF SECTION 07 72 33

SECTION 07 92 00 – JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Control and expansion joints on exposed surfaces.
 - 2. Perimeter joints between wall surfaces and frames of doors and openings.
 - 3. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - 4. Joints indicated or as necessary.
 - 5. Accessories necessary for a complete installation.

1.3 RELATED SECTIONS

- A. Section 04 22 00 – Concrete Unit Masonry.
- B. Section 08 80 00 – Glazing.
- C. Section 09 21 16 – Gypsum Board Assemblies
- D. Section 09 30 19 – Porcelain Tiling.
- E. Division 23 – Mechanical Sections.

1.4 REFERENCES

- A. ASTM International (ASTM)
 - 1. C717, Standard Terminology of Building seals and Sealants.
 - 2. C793, Standard Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
 - 3. C794, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
 - 4. C834, Standard Specification for Latex Sealants.
 - 5. C920, Standard Specification for Elastomeric Joint Sealants.
 - 6. C1193, Standard Guide for Use of Joint Sealants.
- B. Sealant, Waterproofing and Restoration Institute (SWRI)
 - 1. The Processional's Guide.

1.5 SUBMITTALS

- A. Product Data: Technical data for each joint sealant product. Submit written certification from manufacturers of sealants attesting products are suitable for use indicated, verified through in house testing laboratory.
 - 1. Written certification from manufacturers of joint sealants attesting that products comply with specification requirements and suitable for use indicated verified through manufacturers testing laboratory within the past 36 months or since most recent reformulation, whichever is most recent.

- a. Complete instructions for handling, storage, mixing, priming, installation, curing and protection of each type of sealant.
 - b. Manufacturer's letter, clearly indicating proposed lot numbers of each sealant supplied and expiration date sequence.
 - c. Instructions for handling, storage, mixing, priming, installation, curing, and protection of each type of sealant.
 2. Recycled Content:
 - a. Indicate recycled content; indicate percentage of preconsumer and postconsumer recycled content per unit of product.
 - b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
 - c. If recycled content product is part of an assembly, indicate the percentage of recycled content product in the assembly by weight.
 - d. If recycled content product is part of an assembly, indicate relative dollar value of recycled content product to total dollar value of assembly.
 3. Local/Regional Materials:
 - a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
 - b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
 - c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
 - d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.
 4. VOC Data: Submit manufacturer's product data for sealants. Indicate VOC limits of the product. Submit MSDS highlighting VOC limits.
 5. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.
- B. Certificates and Reports:
1. Product Certificates: Manufacturer's product certificate for each kind of joint sealant and accessory.
 2. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
 3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
 4. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 - a. Materials forming joint substrates and sealant backings have been tested for compatibility and adhesion with sealants.
 - b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
 5. Preconstruction Field Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified.
 6. Field Adhesion Test Reports: For each sealant application tested.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Firm having minimum 5 years documented experience and specializing in the installation of sealants.
 - 1. Exposed sealant work (sealants used for air and weatherseals external to curtain wall systems at perimeter, metal panel to panel joints) shall be performed by a single (i.e. one) firm specializing in the installation of sealants who has successfully produced work comparable to project.
 - 2. Concealed sealant work (sealants which are internal to metal framed curtain wall systems, skylights, and providing an air seal) shall be the responsibility of the subcontractor providing erection of the respective system.
- B. Source Limitations: Obtain each type of joint sealant from a single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
 - 2. Pre-construction Field Adhesive Testing: Prior to installation of building sealants, field test their adhesion to joint substrates in accordance with manufacturer's instructions. Perform test in locations indicated by Architect. Perform test for each type of building sealant and each substrate as required by Architect. If required by Architect, arrange for tests to be performed with sealant manufacturer's representative present. Follow-up review by Architect and manufacturer may be required to observe sealant performance over time and may result in re-application of sealant or replacement.
 - 3. Test according to SWRI Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion in peel, and indentation hardness.
- D. Environmental Requirements:
 - 1. Toxicity/IEQ: Comply with applicable regulations regarding toxic and hazardous materials.
 - a. VOC Content of Interior Sealants: Sealants and sealant primers complying with limits for VOC content for SCAQMD when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1) Sealants: 250 g/L.
 - 2) Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3) Sealant Primers for Porous Substrates: 775 g/L.
 - b. Sealants containing aromatic solvents, fibrous talc, formaldehyde, halogenated solvents, mercury, lead, cadmium, chromium and their compounds, are not permitted.
- E. Cleaning: Facade sealants that have collected dirt at the time of Substantial Completion shall be cleaned over the entire facade prior to acceptance by the Owner. 11 months after final completion of the building, if the sealant joints show dirt, they shall again be cleaned over the entire façade.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

- B. Store and handle materials in compliance with manufacturer written instructions to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 degrees F (4.4 degrees C).
 - 2. When joint substrates are wet. Should joints or backing materials become wet, remove and replace backing material with new.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.9 PRE-INSTALLATION CONFERENCES

- A. Refer to Section 01 31 00 – Project Management and Coordination.
- B. In addition, refer to information above concerning Field Adhesive Testing.

1.10 WARRANTY

- A. Installer's Warranty: Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealant work which has failed to provide a weathertight system within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Warranties: Written warranties (weatherseal and stain resistance), signed by sealant manufacturer agreeing to furnish joint sealants to repair or replace those that fail to provide airtight and watertight joints, or fail in adhesion, cohesion, abrasion resistance, stain resistance, weather resistance, durability, or appear to deteriorate in manner not specified in the manufacturer's data as an inherent quality of the material within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.
- C. Warranties specified exclude deterioration or failure of sealants from:
 - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backings, and related materials compatible with one another and with joint substrates under conditions of service and application, as stated by

sealant manufacturer's published data, and as substantiated by the manufacturer for each application through testing.

- B. Liquid Applied Sealants: Comply with ASTM C 920 and requirements indicated for each liquid applied sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- C. Stain Test Response Characteristics: For sealants in contact with porous substrates, provide nonstaining products that have undergone testing according to ASTM C 1248 and do not stain porous joint substrates.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Colors: For fully concealed joints, provide standard color of sealant that has the best overall performance characteristics for the application shown. For exposed joints, match adjacent surface. For exposed joints, submit color samples to architect for approval, from manufacturer's full line of standard colors.
- F. Manufacturer's Representative: Use sealant produced by manufacturer who agrees to send a qualified technical representative to site upon request for the purpose of rendering advice concerning the recommended installation of manufacturer's materials.
- G. Sealants: Self leveling compounds for horizontal joints in pavements and nonsag compounds elsewhere except as shown or specified.
- H. Silicone Sealant: Comply with ASTM C920, Type M, Grade NS, Class 25; use NT, M, A and O.
 - 1. Use: Precast Concrete Joints between metals, glass and plastics (Two part silicone sealants).
 - 2. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates. The minimum pli value after 7 day immersion shall not be less than 13 when tested in strict accordance with ASTM C794 Adhesion and Peel.
 - 3. Cure System and Oil Content: Neutral Cure System specifically manufactured with controlled oil content to eliminate oil migration into sealed substrates and residue rundown over and onto adjacent substrates.
 - 4. Product and Manufacturer: Dow Corning; 756 Silicone Building Sealant - HP with Additive.
- I. Silicone Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Use: Precast Concrete Joints between metals, glass and plastics (Single component sealants).
 - 2. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates.
 - 3. Cure System and Oil Content: Neutral Cure System specifically manufactured with controlled oil content to eliminate oil migration into sealed substrates and residue rundown over and onto adjacent substrates.
 - 4. Product and Manufacturer:
 - a. BASF Building Systems; Omniseal 50.
 - b. Dow Corning Corporation; 756 SMS, 791, 795, 995 as applicable.
 - c. GE Advanced Materials, Silicones; SilGlaze II SCS2800, SilPruf NB SCS9000, SilPruf SCS2000, or UltraPruf II SCS2900 as applicable.
 - d. Sika Corporation, Construction Products Division; SikaSil-C995.
- J. Polyurethane Sealants: ASTM C920, Type M, Grade NS, Class 25; use NT, M, A and O.

1. Use: Typical Wall and Floor Joints (Two part polyurethane sealants).
 2. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates.
 3. Products and Manufacturers:
 - a. BASF Building Systems; MasterSeal NP 2.
 - b. Pecora Corporation; Dynatred.
 - c. Sika Corporation, Construction Products Division; Sikaflex 2c NS or Sikaflex 2c NS TG as applicable.
- K. Two Part Polyurethane Sealants: ASTM C920, Type M, Grade NS, Class 50; use NT, M, A and O.
1. Use: Typical Wall and Floor Joints (Two Part Polyurethane Sealants).
 2. Properties: Performance: Nonstain, nonbleed, nonstreaking to sealed and adjacent substrates. The minimum pli value after 7 day immersion shall not be less than 13 when tested in strict accordance with ASTM C794 Adhesion in Peel.
 3. Products and Manufacturers: One of the following:
 - a. Schnee-Morehead, Inc.; Permthane SM 7200.
 - b. Sika Corporation, Inc.; Sikaflex - 2c NS TG.
 - c. BASF Construction Chemicals; NP 2.
- L. Mildew Resistant Silicone Sealant: ASTM C920, Type S, Grade NS, Class 25, Use NT, Substrate uses G, A, and O; and containing fungicide for mildew resistance; acid curing.
1. Use: Joints at toilet fixtures, toilet room countertops and vanities, wet areas, and janitor closet mop receptor to wall transition.
 2. Products: Provide one of the following:
 - a. BASF Building Systems; Omniplus.
 - b. Dow Corning; 786 Mildew Resistant Silicone Sealant.
 - c. GE Silicones; Sanitary SCS 1700.
- M. Latex Sealant: Nonelastomeric, one part, nonsag, paintable latex sealant that is recommended for exposed applications on the interior. Complying with ASTM C 834, Type OP (opaque sealants):
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; AC-20 + Silicone.
 - b. BASF; MasterSeal.
- N. Acoustical Joint Sealant: Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; AC-20 FTR or AIS-919.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.
- O. Sealant Backing: Provide sealant backings that are nonstaining; compatible with joint substrates, sealants, primers, and joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
1. Cylindrical Sealant Backings: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding backings of flexible plastic foam complying with ASTM C 1330, and of type indicated below. Select shape and density of cylindrical sealant backings in consultation with the manufacturer for proper performance in specific condition of use in each case.
 2. Type C: Closed cell polyethylene foam material with surface skin, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state; one of the following:
 - a. HBR Closed Cell Backer Rod; Nomaco, Inc.
 - b. MasterSeal 920 Closed-Cell Backer-Rod; BASF Construction Chemicals.

- P. Miscellaneous Materials:
1. Primer: Material recommended, as verified through compatibility and adhesion testing, by joint sealant manufacturer for the substrates indicated to be sealed.
 2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
 3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and which will not stain nor mar the finish of surface adjacent to joints to which it is applied.
 4. Cork Joint Filler: Resilient and nonextruding, ASTM D1752, Type II.
 5. Bond Breaker Tape: Polyethylene, TFE fluorocarbon, or plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants for compliance with requirements for joint configuration, installation tolerances, and conditions affecting sealant performance. Proceed with installation after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with the recommendations of joint sealant manufacturer and requirements:
1. Remove foreign material from joint substrates interfering with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), existing joint sealants, oil, grease, water, surface dirt, and frost.
 2. Clean concrete, masonry, unglazed surfaces of tile and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil free compressed air.
 3. Remove laitance and form-release agents from concrete.
 4. Clean metal, glass, porcelain enamel, glazed surfaces of tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming (Elastomeric Sealants Only): Prime joint substrates where recommended in writing by joint sealant manufacturer, based on prior testing and experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

- A. Silicone Glazing Sealants: Refer to Section 08 80 00.

- B. Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- C. Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants applicable to materials, applications, and conditions indicated.
- D. Sealant Backings: Install sealant backings to support sealants during application and at position necessary to produce cross sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings. Trim for tight fit around obstructions or elements penetrating the joint.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that become wet before sealant application and replace with dry sealant backings.
 - 4. Install bond breaker tape behind sealants where backings are not used between sealants and back of joints.
- E. Weeps and Vents: Install weeps and vents into joints at the same time sealants are being installed. Locate weeps and vents spaced recommended by sealant manufacturer and the window and curtain wall fabricator and erector. Do not install weeps and vents at outside building corners. Do not install vents at horizontal joints immediately below shelf angles, sills, and through wall flashings.
- F. Sealants: Install sealants by proven techniques resulting in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at same time sealant backings are installed.
 - 1. Apply sealants in depth in accordance with manufacturer's recommendations and recommended general proportions and limitations.
 - 2. Apply elastomeric sealants, in joints not subject to traffic or abrasion, to a depth equal to 50% of the joint width, but not less than 1/4 inch (6 mm) and not more than 1/2 inch (13 mm).
 - 3. Apply nonelastomeric sealants to a depth approximately equal to the joint width.
- G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform, beads to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces. Tool exposed surfaces of sealants to the profile shown, or if none is shown, tool slightly concave.
 - 1. Use masking tape to protect adjacent surfaces of recessed tooled joints.
 - 2. Provide a slight wash on horizontal joints where horizontal and vertical surfaces meet.
 - 3. Against rough surfaces or in joints of uneven widths avoid the appearance of excess sealant or compound by locating the compound or sealant well back into joint wherever possible.
- H. Installation of Preformed Silicone Sealant System:
 - 1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 - 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) inside masking tape.

3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- I. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
- J. Acoustical Sealant Installation: At sound rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer written recommendations.

3.4 FIELD QUALITY CONTROL

- A. Field Adhesion Testing: Field test exterior wall joint sealant adhesion to joint substrates:
1. Extent of Testing: Test completed and cured sealant joints:
 - a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer field adhesion hand pull test criteria.
 4. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure original sealant surfaces are clean and new sealant contacts original sealant.
- B. Evaluation of Field Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 SITE ENVIRONMENTAL PROCEDURES

- A. Indoor Air Quality: Provide temporary ventilation during work. Coordinate interior application of sealants with interior finishes schedule.

3.6 CLEANING AND PROTECTION

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- B. Protect joint sealants during and after curing from contact with contaminating substances and from damage so sealants are without deterioration or damage at time of Substantial Completion. If, despite protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 07 92 00

SECTION 08 16 00 – FIBERGLASS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Providing Fiberglass Reinforced Plastic (FRP) Doors and Fiberglass Resin Transfer Molded Door Frames, with all fasteners and accessories required for a complete installation.

1.3 RELATED SECTIONS

- A. Section 04 22 00 – Concrete Unit Masonry: Masonry work in which doorframes are installed.
- B. Section 08 80 00 - Glazing: Vision glazing in doors, if any.

1.4 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Door Assembly:
 - a. ASTM C518, Standard test method for steady state thermal transmission properties by means of the heat flow meter apparatus.
 - 2. Laminate Properties:
 - a. ASTM D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics = 15.75 psi
 - b. ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
 - c. ASTM D638 Standard Test Method for Tensile Properties of Plastics = 15,000 psi.
 - d. ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials Strength = 39,000 psi
 - e. ASTM D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
 - f. ASTM D1761, Standard Test Method for Mechanical Fasteners in Wood
 - g. ASTM D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor = 57
 - h. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - i. ASTM G155, Standard Practice for Operating Xenon Arc light Apparatus for Exposure of Non-Metallic Materials
 - 3. Core Properties:
 - a. ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
 - b. ASTM D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics
 - c. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
 - d. WDMA TM-10 and TM-5 Firestop ASTM E2074 U.L. 10(b)

B. Qualifications:

1. Manufacturer Qualifications: A company specialized in the manufacture of fiberglass reinforced plastic (FRP) doors and frames as specified herein with a minimum of 25 years documented experience and with a record of successful in-service performance for the applications as required for this project.
2. Installer Qualifications: An experienced installer who has completed fiberglass door and frame installations similar in material, design, and extent to those indicated and whose work has resulted in construction with a record of successful in-service performance.
3. Source Limitations: Obtain fiberglass reinforced plastic doors and frames through one source fabricated from a single manufacturer, including fire rated fiberglass frames.
4. Source Limitations: Hardware and accessories for all FRP doors as specified in Section 08 71 00 should be provided and installed by the fiberglass door and frame manufacturer.
5. Source Limitations: Glass for windows in doors shall be furnished and installed by door and frame manufacturer in accordance with Section 08 80 00.

1.5 SUBMITTALS

A. Product Technical Data Including:

1. Acknowledgment that products submitted meet requirements of standards referenced.
2. Manufacturer shall provide certificate of compliance with current local and federal regulations as it applies to the manufacturing process.
3. Manufacturer's installation instructions.
4. Schedule of doors and frames indicating the specific reference numbers as used on drawings, door type.
5. Details of core and edge construction. Include factory-construction specifications.
6. Certification of manufacturer's qualifications.

B. Submittal Drawings For Customer Approval Shall Be Submitted Prior To Manufacture And Will Include The Following Information And Formatting:

1. Summary door schedule indicating the specific reference numbers as used on Architect's drawings, with columns noting door type, frame type, size, handing, accessories and hardware.
2. A drawing depicting front and rear door elevations showing hardware with bill of material for each door.
3. Drawing showing dimensional location of each hardware item and size of each door.
4. Individual part drawing and specifications for each hardware item and FRP part or product.
5. Construction and mounting detail for each frame type.

C. Samples:

1. Provide one (1) 21 inch x 18 inch completely assembled (hinged) door and frame corner section, with faces and edges representing typical color and finish. One (1) edge shall be exposed for view of interior door and frame composition. Sample shall include six (6) inch light opening as well as standard cutouts for hinges and strike plates.

D. Operation and Maintenance Manuals:

1. Include recommended methods and frequency for maintaining optimum condition of fiberglass doors and frames under anticipated traffic and use conditions.
2. Include one (1) set of final as built drawings with the same requirements as mentioned in Paragraph B above.
3. Include certificate of warranty for door and frame listing specific door registration numbers.
4. Include hardware data sheets and hardware manufacturer's warranties.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Each door and frame should be delivered individually crated for protection from damage in cardboard containers, clearly marked with project information, door location, specific reference number as shown on drawings, and shipping information. Each crate should contain all fasteners necessary for installation as well as complete installation instructions.
- B. Doors should be stored in the original container out of inclement weather for protection against the elements.
- C. Handle doors pursuant to the manufacturer's recommendations as posted on outside of crate.

1.7 WARRANTY

- A. Warranty all fiberglass doors and frames for a period of 25 years against failure due to corrosion. Additionally, warranty all fiberglass doors and frames on materials and workmanship for a period of ten (10) years, including warp, separation or delamination, and expansion of the core.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specifications are based on Chem-Pruf Door Co., Ltd., Brownsville, Texas; (800) 444-6924. Manufacturers listed below who produce products equivalent to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with requirements of Division 1 regarding substitutions to be considered.
 - 1. Cline FRP Doors, Bradenton, Florida; (800) 648-6736
 - 2. Special-Lite, Inc., Decatur, Michigan; (800) 821-6531
 - 3. Tiger Door Company, LLC, An Overly Door Company, Omaha, Nebraska; (888) 891-4416

2.2 FRP DOORS

- A. Doors shall be made of fiberglass reinforced plastic (FRP) using chemically proven resins resistant to contaminants typically found in the environment for which these specifications are written. Doors shall be 1-3/4 inch thick and of flush construction, having no seams or cracks. All doors up to 4 feet-0 inches x 8 feet-0 inches shall have equal diagonal measurements with a maximum tolerance of +/- 1/32 inch.
- B. Door Plates shall be +/- 0.125 inch thick, molded in one continuous piece, starting with a 25 mil polyurethane coating of the color specified, integrally molded with at least two (2) layers of 1.5 ounce per square foot fiberglass mat and one (1) layer of 13 ounce per square yard unidirectional roving. This will yield a plate weight of 0.97 lbs per square foot at a ratio of 30/70 glass to resin.
- C. Stiles and Rails shall be constructed starting from the outside toward the inside, of a 25 mil polyurethane coating of the color specified followed by a matrix of at least three (3) layers of 1.5 ounce per square foot of fiberglass mat. The stile and rail shall be molded in one continuous piece to a U-shaped configuration and to the exact dimensions of the door. In this manner there will be no miter joints or disparate materials used to form the one-piece stile and rail.
- D. Core material shall be 2 psf expanded polyurethane foam, which completely fills all voids between the doorplates. Class A in accordance with ASTM E-84 with a maximum flame spread of 75 and maximum smoke development of 450.

- E. Internal Reinforcement shall be NWPF of sufficient amount to adequately support required hardware and function of the same.
- F. Finish of door and frame shall be identical in color and texture. At time of manufacture, 25 mil of resin-rich polyurethane coating must be integrally molded into both the door and frame. Secondary painting to achieve color is not acceptable.
- G. Window openings shall be provided for at time of manufacture and shall be completely sealed so that the interior of the door is not exposed to the environment. Fiberglass retainers who hold the glazing in place shall be resin transfer molded with a profile that drains away from glazing. The retainers must match the color, texture and finish of the doorplates. Glass shall be furnished and installed by door and frame manufacturer.
- H. Louver openings shall be sealed in the same manner as the window openings. Louvers are to be solid fiberglass inverted "V" vanes and shall match the color, texture and finish of the doorplates.
- I. Transoms shall be identical to the doors in construction, materials, thickness and reinforcement.

2.3 FRP FRAMES

- A. Frames shall be fiberglass and manufactured using the resin transfer method in closed rigid molds to assure uniformity in color and size. Beginning with a minimum 25 mil polyurethane coating and a minimum of two (2) layers continuous strand fiberglass mat saturated with resin, the frame will be of one-piece construction with molded stop. All frame profiles up to 3/4 inch will be solid fiberglass. All frame profiles greater than 3/4 inch shall have a core material of 2 psf polyurethane foam. Metal frames or pultruded fiberglass frames will not be accepted.
- B. Finish of frame shall be identical in color and texture to the door. 25 mil resin rich polyurethane coating will be integrally molded into the frame at time of manufacture. Secondary painting to achieve color is not acceptable.
- C. Jamb/Header connection shall be coped by CNC for tight fit.
- D. Internal Reinforcement shall be continuous within the structure to allow for mounting of specified hardware. Material shall be completely non-organic with a minimum hinge screw holding value of 656 lbs. Frame screw holding value to accommodate screw shall be minimum of 1,000 lbs per screw. Documented strength of frame screw holding value after third insert must be submitted. Dissimilar materials, such as steel, will be deemed unacceptable as reinforcement for hardware attachment.
- E. Mortises for hardware shall be accurately machined by CNC to hold dimensions to +/- 0.010 inch in all three (3) axis.
- F. Hinge pockets shall be accurately machined by CNC to facilitate heavy-duty hinges at all hinge locations, using spacers when standard weight hinges are used.

2.4 HARDWARE

- A. Due to the special nature of the material in this Section, all related hardware as specified must be furnished and installed by the door and frame manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION CONDITIONS

- A. Verification of Conditions:

1. Openings are correctly prepared to receive doors and frames.
2. Openings are correct size and depth in accordance with shop drawings or submittals.

B. Installer's Examination:

1. Have the installer examine conditions under which construction activities of this section are to be performed and submit a written report if conditions are unacceptable.
2. Transmit two (2) copies of the installer's report to the architect within 24 hours of receipt.
3. Beginning construction activities of this Section before unacceptable conditions have been corrected is prohibited.

3.2 INSTALLATION

- A. Install door-opening assemblies in accordance with shop drawings and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.
- B. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.
- C. Site tolerances: Maintain plumb and level tolerance specified in manufacturer's printed installation instructions.
- D. Fire labeled doors and frames must be installed in strict accordance with manufacturer's instructions and the latest revision of NFPA 80.

3.3 ADJUSTING

- A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.
- B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.4 CLEANING

- A. Clean surfaces of door opening assemblies and exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.5 PROTECTION OF INSTALLED PRODUCTS

- A. Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection and acceptance.

END OF SECTION 08 16 00

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Access doors in gypsum board, masonry partitions, and plaster/stucco soffits, where shown or required.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's literature, including schedules, charts, and illustrations to indicate the performance, fabrication, procedures, product variations, and accessories.
 - 2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers listed whose products meet or exceed the specifications are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing access doors meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions in order to be considered.
 - 1. The Bilco Company.
 - 2. Acudor Products, Inc.
 - 3. Babcock-Davis (Cierra Products).
 - 4. Bar-co, Alfab, Inc., Enterprise, AL.
 - 5. J. L. Industries, Incorporated.
 - 6. Karp Associates, Inc.
 - 7. Larsen's Manufacturing Company.
 - 8. Nystrom Building Products Co. Inc.
 - 9. The Williams Brothers Corporation of America.
- B. Specifications are based on DW-5058 as manufactured by Acudor Products, Inc.

2.2 PRODUCTS

- A. General: The following access panel types are for selection as required whether or not indicated on drawings. The contractor shall evaluate the specific requirements and provide the appropriate system based on the condition, as all types may not be required on the project. The inclusion of any of the listed access panel types does not necessarily imply that the condition exists in the scope of work.
- B. Standard type flush stainless door for CMU wall construction:
 - 1. Size: 12 inches x 12 inches unless otherwise noted in drawings or specifications.
 - 2. Material: Stainless Steel, Type 304.
 - 3. Hinges: Concealed, spring loaded hinge pin allow panel to open to 90 degrees.

4. Finish: #4 Brushed.
5. Frames: Stainless Steel, Type 304.
6. Doors: Stainless Steel, Type 304.
7. Lock: Vandal-resistant stainless steel cam lock.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and provide panels to the trade that is constructing the material being penetrated.

3.2 LOCATIONS

- A. Provide where required by code and where needed to service and maintain equipment.
- B. If not shown on the drawings, consult the Architect before locating in finished spaces.

END OF SECTION 08 31 13

SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Glazed aluminum curtain walls.
 - 2. Exterior and interior manual swing entrance doors.
 - 3. Accessories necessary for a complete installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the State of Texas with experience in the design of curtainwalls and aluminum storefronts to design glazed aluminum curtain walls using performance requirements and design criteria indicated.
- B. Provide curtain wall assembly, storefront system, and windows by a single source and tested as a combined single assembly.
- C. System Description: Curtainwall assembly fabricated from aluminum stick framed system with exposed interior and exterior metal framing. Design system to allow for installation tolerances, expansion and contraction of adjacent materials and joint design.
 - 1. Drawings are diagrammatic and do not identify or solve thermal or structural movement, glazing, anchorage, or moisture disposal. Details establish basic dimension of unit, sight lines, and profiles of members.
 - 2. Glass, sealants, and interior finishes do not contribute to framing member strength, stiffness, or lateral stability.
 - 3. Design and fabricate glazing systems for interior glazing.
 - 4. Design perimeter conditions to allow for installation tolerances, expansion and contraction of adjacent materials, and sealant manufacturer's recommended joint design.
 - 5. Design attachments to address site conditions, expansion, and contraction movements to eliminate possibility of loosening, weakening, or fracturing connection between units and building structure or between units themselves.
 - 6. Allow for expansion and contraction due to structural movement without detriment to appearance or performance.
 - 7. Design system to drain to exterior face of wall, water entering joints and condensation occurring within system by drain holes and gutters of adequate size to evacuate water without infiltration to interior or the top of lower lites of glass.
 - 8. Design metal faces to be visually flat under lighting conditions.
 - 9. Design interior dense EPDM wedge gasket with sealed corners, with maximum 30% compression when glazed, to create a water and air seal.
 - 10. Design rigid isolators to maintain flatness of face caps and provide thermal break between exterior and interior members.
 - 11. For stresses placed on structural silicone sealants, maintain sealant manufacturer's recommended maximum.
 - 12. Not Permitted: Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system.

- D. Performance Criteria: Coordinate with Section 084100 for performance criteria, fabrication, and erection standards. Provide curtain wall assemblies to meet or exceed performance requirements:
1. Design and fabricate curtain wall to withstand the operating loads without measurable permanent deflection. Limit deflections to provide the normal degree of rigidity required to avoid glass breakage, air infiltration, and objectionable results of excessive flexibility.
 2. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 3. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- E. Structural Loads:
1. Wind Loads: Design, fabricate, and install framing system to withstand the maximum inward and outward wind pressures required by IBC.
 - a. Basic Wind Speed: Refer to Structural Drawings.
 - b. Exposure Category: Refer to Structural Drawings.
 - c. Risk Category: Refer to Structural Drawings.
 2. Deflection of Framing Members: At design wind pressure:
 - a. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
 - b. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
 - 1.) Operable Units: Provide a minimum 1/16 inch (1.6 mm) clearance between framing members and operable units.
 - c. Cantilever Deflection: Where framing members overhang an anchor point:
 - 1.) Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans less than 11 feet 8-1/4 inches (3.6 m).
 - d. Do not permit permanent deformation (set) in metal framing work. Permanent deformation, fastener, weld, or gasket failure, component breakage or disengagement shall not occur under wind loading equal to 1.5 times the wind loads (positive or negative). Permanent deformation shall be taken as deflection without recovery exceeding 1/1000 times span.
- F. Structural: Test according to ASTM E 330:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

- G. Air Infiltration: Test according to ASTM E 283 for infiltration:
 - 1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa) and 6.24 lbf/sq. ft. (300 Pa).
- H. Water Penetration under Static Pressure: Test according to ASTM E 331:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
- I. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).
 - 2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- J. Interstory Drift: Accommodate design displacement of adjacent stories indicated.
 - 1. Design Displacement: Indicated on Drawings.
 - 2. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.
- K. Energy Performance: Certify and label energy performance according to NFRC:
 - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) as determined according to NFRC 100.
 - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
 - 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC certified condensation resistance rating of no less than 35 as determined according to NFRC 500. Excessive condensation is defined as the accumulation of uncontrolled condensate flowing from the curtain wall at any location, or visible ice, frost, or water on more than 5% of the area of any module of the exterior wall.
- L. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332:
 - 1. Outdoor-Indoor Transmission (OITC) Class: Minimum 34.
- M. Sound Transmission: Provide window wall and storefront systems with fixed glazing and framing areas having sound transmission characteristics of:
 - 1. Sound Transmission Class (STC): Minimum 31 standard and 37 laminated STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.
- N. Blast Resistance:
 - 1. Hazard Rating: Minimal Hazard per ASTM F 1642.
 - 2. Performance Condition: 3b per GSA-TS01.
- O. Windborne Debris Impact Resistance: Pass missile impact and cyclic pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 for Wind Zone 4.
 - 1. Large Missile Test: For glazed openings located within 30 feet (9.1 m) of grade.
 - 2. Small Missile Test: For glazed openings located more than 30 feet (9.1 m) above grade.
- P. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient Air Temperature: That which produces an exterior metal surface temperature of 180 degrees F (82 degrees C).
 - b. Low Exterior Ambient Air Temperature: 0 degrees F (minus 18 degrees C).
- Q. Structural Sealant Joints:
1. Designed to carry gravity loads of glazing.
 2. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).
- R. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural sealant glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
- S. Design Modifications: Submit design modifications necessary to meet performance requirements and field coordination.
1. Variations in details or materials shall not adversely affect the appearance, durability, or strength of components, nor shall variations cause excessive stress, or deflections, to building structural frame.
 2. Maintain general design concept without altering size of members, profiles, and alignment.

1.4 SUBMITTALS

- A. Combined Submittals: Combine submittals for exterior curtainwall and storefronts into a single submission. Submit combined shop drawing which has been reviewed, annotated, and coordinated by each of the principal exterior cladding subcontractors.
1. As an indication of review, and as a condition of acceptance by the Architect, provide combined submittal with a cover sheet clearly indicating the signatures of the Contractor and each exterior cladding subcontractor.
 2. Coordinate curtainwall, storefronts and entrances, windows, ACM, and window wall submittals.
- B. Product Data: Manufacturer technical data for each type of product, including construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: Submit plans, elevations, sections, full size details, and attachments to other work.
1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 2. Include full size isometric details of each vertical to horizontal intersection of glazed aluminum curtain walls, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.

- f. Thermal breaks.
 - g. Interface with building construction.
- 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- 4. Indicate glazing details, methods, locations of various types and thickness of glass, emergency breakout locations, and internal sealant requirements.
- 5. Indicate locations of exposed fasteners and joints for Architect's acceptance.
- D. Fabrication Sample (Mock Up Drawings): Submit drawings for field mockup of each vertical to horizontal intersection of assemblies, made from 12 inch (300 mm) lengths of full size components and showing details of the following:
 - 1. Joinery, including concealed welds.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.
- E. Delegated Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for the preparation.
- F. Structural Calculations: Submit sealed copies of structural calculations indicating complete compliance with the specified performance requirements. Submit calculations prepared, signed, and sealed by a Professional Engineer licensed in the State of Texas.
- G. Preconstruction Laboratory Mockup Testing Submittals: Submit the following:
 - 1. Testing Program: Developed specifically for Project.
 - 2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
 - 3. Record Drawings: Record drawings prepared from as built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
- H. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.
 - 1. Basis for Certification: NFRC certified energy performance values for each glazed aluminum curtain wall.
- I. Reports: Submit the following:
 - 1. Product Test Reports: Submit report for tests performed by a qualified testing agency.
 - 2. Quality Control Program: Program developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality control reports.
 - 3. Source quality control reports.
 - 4. Field quality control reports.
- J. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- K. Maintenance Data: Submit maintenance data to include in maintenance manuals.

- L. Maintenance Data for Structural Sealant: For structural sealant glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality control program.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements of IBC with Austin amendments for building cladding.
 - 2. Energy Code: Comply with applicable provisions of the IECC.
 - 3. Surface Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: 25 or less.
 - b. Smoke Developed Index: 450 or less.
 - 4. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
 - 5. Welding Standards: Welding shall be performed by skilled and qualified mechanics. Welding shall be performed in accordance with the applicable provisions of AWS D1.1 *Structural Welding Code - Steel* and AWS D1.2 *Structural Welding Code - Aluminum*.
 - 6. Federal Standard 16 CFR 1201, Consumer Product Safety Commission (CPSC): *Safety Standard for Architectural Glazing Materials*, published in Code of Federal Regulations (CFR).
 - a. Comply with applicable requirements of authorities having jurisdiction, wherever requirements conflict the more stringent shall be required. Obtain approvals from authorities.
 - b. As a minimum provide safety glazing complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.
 - 7. Structural Sealant Glazing: Comply with ASTM C 1401 for design and installation of structural sealant glazed curtain walls.
 - 8. Energy Performance Standards: NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
- B. Manufacturer/Fabricator Qualifications: Fabricator specializing in the fabrication of aluminum framed window wall and window systems and components, having minimum 10 years documented experience, and with sufficient production capacity, organized quality control and testing procedures, and published written and illustrated installation manuals, to produce and install the entrance assemblies required.
- C. Installer Qualifications: Firm that specializes in the erection of aluminum framed window wall, storefront, and window systems, having minimum 10 years documented experience, and approved or certified by manufacturer/fabricator.
 - 1. Engineering Responsibility: Prepare data for curtainwall, storefront, and window systems, including Shop Drawings, based on testing and engineering analysis of manufactured units in systems similar to those indicated.
 - a. Professional Engineer Qualifications: A professional engineer who is legally licensed to practice in the State of Texas, experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of heavy glass storefront and entrance system similar to those indicated in material, design, and extent.

- D. Laboratory Mockup Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.
- E. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.
- F. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- G. Structural Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain wall assemblies.
- H. Source Limitations: Obtain components of curtain wall system, including framing entrances and accessories, from single manufacturer.
- I. Preinstallation Conference: Conduct conference at site.
- J. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Perform testing on mockups according to specified requirements.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- K. Preconstruction Laboratory Mockups:
 - 1. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform testing on preconstruction laboratory mockups.
 - 2. Build preconstruction laboratory mockups at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
 - a. Size and Configuration: As indicated on Drawings.
 - b. Notify Architect seven days in advance of the dates and times when preconstruction laboratory mockups will be constructed and tested.
 - 3. Preconstruction Laboratory Mockup Testing Program: Test preconstruction laboratory mockups according to requirements. Perform the following tests in the following order:
 - a. Structural: ASTM E 330 at 50 percent of positive test load.
 - b. Air Infiltration: ASTM E 283.
 - c. Water Penetration under Static Pressure: ASTM E 331.
 - d. Water Penetration under Dynamic Pressure: AAMA 501.1.
 - e. Structural: ASTM E 330 at 100 percent of positive and negative test loads. Repeat the following:
 - 1) Air Infiltration: ASTM E 283.
 - 2) Water Penetration under Static Pressure: ASTM E 331.
 - f. Interstory Drift: AAMA 501.4 at 100 percent of design displacement. Repeat the following:
 - 1) Air Infiltration: ASTM E 283.

- 2) Water Penetration under Static Pressure: ASTM E 331.
- g. Vertical Interstory Movement: AAMA 501.7. Repeat the following:
 - 1) Air Infiltration: ASTM E 283.
 - 2) Water Penetration under Static Pressure: ASTM E 331.
- h. Thermal Cycling: According to AAMA 501.5. Repeat the following:
 - 1) Air Infiltration: ASTM E 283.
 - 2) Water Penetration under Static Pressure: ASTM E 331.
- i. Structural: ASTM E 330 at 100 and 150 percent of positive and negative test loads. Repeat the following:
 - 1) Air Infiltration: ASTM E 283.
 - 2) Water Penetration under Static Pressure: ASTM E 331.
- L. Laboratory Mockup Testing: Curtain wall mock up testing shall include components of fixed window units, glazed framing including captured mullions and SSG mullions, and storefront units in mock up.
 - 1. Laboratory Mockup Testing: Provide mockups as specified for testing. Verify required mockup submittals are reviewed and have received final approval from the Architect prior to construction of the mockups.
 - a. Laboratory testing mockups are used as a standard for judging visual and performance acceptability of the Work for the project. Replace unsatisfactory work as directed. Provide personnel to construct exterior wall mockups who will be the same personnel who will be performing and supervising the actual Work. Simulate actual construction conditions as accurately as possible in every way. Provide extra materials necessary to replace any which fail during tests. Cut glass used in mockups to the minimum tolerances expected in the final exterior wall installation.
 - b. Size: As shown but not less than the requirements of AAMA Standard 501 and ASTM E 331 Section 9. Provide larger mockup(s) if the proposed exterior wall details create a condition requiring a larger mockup(s) for proper evaluation and testing. Provide mockups at wall testing facility complete with glass, aluminum framing, metal panels, anchors, connections, flashings, sealants, and joint fillers as accepted on the mockup shop drawings. Do not take special precautions or use techniques that do not represent those to be used on the work.
 - c. Laboratory Testing: Notify the Architect of the readiness of the mockups for preliminary and final testing. Do not begin the testing program without the presence of the Owner's representative and the Architect.
 - 1) Preliminary Test: Conduct single static pressure test at 50 percent of the maximum Wind Pressure followed by a single test for water penetration at 50 percent of the pressure specified.
 - a) The preliminary test is purposely limited to a single event. No interim or repeat preliminary testing for Contractor benefit or correction of systems shall be permitted.
 - 2) Preform tests of the mockup(s) in accordance with the standards except as modified, in the order listed, and in accordance with the specified performance criteria. Tests 1 and 5 shall be conducted at 1.57 lbf/sq. ft. (75 Pa) and 6.24 lbf/sq. ft. (300 Pa), respectively. Tests 2, 3, and 6 shall be conducted at 12 lbf/sq. ft. (600 Pa) for 1 cycle, maintaining the test pressure for 15 minutes.
 - a) Test 1 (For Air Infiltration): ASTM E 283. Extraneous air leakage (tare) shall be limited to 10 percent or less of the net air leakage through the exterior wall assembly as provided under ASTM E 283. Provide pressure taps as required within the test chamber to ensure

- uniform stratification of design test pressure across the exterior wall assembly.
- b) Test 2 (For Water Penetration - Uniform Static Pressure): ASTM E 331.
 - c) Test 3 (For Water Penetration - Dynamic Pressure): AAMA 501.1.
 - d) Test 4 (For Structural Performance): ASTM E 330, Method B, test to .5, and 1.0 times the wind pressure, during test. Deflection readings shall be taken at end connections and midspans of main framing members, at intersections of framing members and at midspans of glass holding members, glass, and panels. Take readings for both positive and negative loading. If failure occurs through glass breakage prior to achieving 1.5 times the maximum wind pressure, replace glass and repeat test. Two successive failures of the same light or panel not otherwise attributable to inherent glass defects will be considered unacceptable. Further tests shall be suspended until deficiencies are corrected, which may include increasing the stiffness of glass holding members and/or adjustment of the glazing details.
 - e) Test 5 (Retest for Air Infiltration): ASTM E 283. Extraneous air leakage (tare) shall be limited to 10 percent or less of the net air leakage through the exterior wall assembly as provided under ASTM E 283. Provide pressure taps as required within the test chamber to ensure uniform stratification of design test pressure across the exterior wall assembly.
 - f) Test 6 (Retest for Water Penetration, Uniform Static Pressure): ASTM E331.
 - g) Test 7 (For Structural Performance): ASTM E 330, Method B, except conduct test to 1.5 times the maximum wind pressure. Record pressures and deflections at 1.5 times the wind pressure, during test.
 - h) Test 8 (For Live Load Deflection Performance): AAMA 501.4 Modified. Test for live load deflection by applying vertical load to the frame supporting the mockup specimen, so as to induce a deflection in the mockup equivalent to the live load deflection identified on the drawings at the location the mockup is simulating. The load shall be applied and released through ten (10) cycles. Visually inspect mockup specimen after each displacement.
 - i) Test 9 (Exterior Window Maintenance Equipment Test): Perform concentrated load testing on the exterior wall maintenance tie back equipment attached to the exterior wall framing. Apply outward, inward, and side-loading of a magnitude and for a duration as required to comply with the authorities having jurisdiction for window washing equipment. There shall be no failure or gross permanent distortion of the tie back equipment or any part of the exterior wall framing.
 - j) Test 10 (For Thermal Transmittance and Condensation Resistance): At the completion of Test 9, carefully disassemble the glass, glazing, and metal framing components and reassemble them as a mockup, and test the mockup, in accordance with AAMA 1503.1.
- d. Corrective Measures: Correct deficiencies in mockups observed during testing and repeat tests as required to show compliance with performance standards. Deficiencies requiring repair or modification to mockup(s) require complete retesting of mockup(s) beginning with the specified Preliminary Test unless otherwise directed by the Architect.
- 1) The Owner will pay the cost of the first mock up test. The cost of subsequent tests and retesting is the responsibility of the contractor. The

Contractor shall bear costs for additional retesting until compliance with performance standards is accomplished.

- 2) Incorporate corrective measures indicated by the test report into the final exterior wall assemblies after review by the Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Identify components of curtainwall work after fabrication by marks clearly indicating location in the building. Package components to protect components from damage during shipping and handling.
- B. Storage on Site: Store units, components, and materials in clean, dry location, away from uncured concrete, masonry work, sprayed on fireproofing work, and construction activities. Cover with nonstaining waterproof paper, tarpaulin, or polyethylene sheeting to permit circulation of air inside the covering.
- C. Keep handling on site to a minimum. Exercise care to avoid damage to finishes of metals or breakage of glass.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions of supporting structure by field measurements before fabrication so curtainwall work is accurately designed, fabricated, and fitted to the structure. Indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Use Contractor's lines and benchmarks as a basis for measurements.
 1. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating curtainwalls without field measurements. Coordinate supporting structure construction to ensure actual dimensions correspond to established dimensions.

1.8 WARRANTY

- A. Assembly Warranty: Written warranty signed by manufacturer, Contractor, and Installer in which the manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including, but not limited to, excessive deflection.
 - c. Glass breakage due to defective design.
 - d. Noise or vibration created by wind and thermal and structural movements.
 - e. Deterioration of metals, metal finishes, and materials beyond normal weathering.
 - f. Water penetration through fixed glazing and framing areas.
 - g. Deterioration of materials and finishes beyond normal weathering.
 - h. Failure of insulating glass.
 - i. Noise or vibration created by wind and thermal and structural movements.
 - j. Failure of operating components.
 2. Warranty Period: Ten (10) years from date of Substantial Completion.
- B. Finish Warranty: Written warranty signed by manufacturer in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory applied finishes within specified warranty period.
 1. Deterioration includes, but is not limited to, the following:

- a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
- b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: Twenty (20) years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

- A. Entrance Door Hardware:
 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 FRAMING

- A. Basis of Design Manufacturer/Product: Kawneer North America, 1600 Series or equivalent product from list of approved manufacturers. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.
 1. Arcadia, Inc.
 2. Bruce Wall Systems Corporation.
 3. CMI Architectural.
 4. EFCO Corporation.
 5. EXTECH/Exterior Technologies, Inc.
 6. Oldcastle Building Enclosure.
 7. Pittco Architectural Metals, Inc.
 8. SAFTI FIRST Fire Rated Glazing Solutions.
 9. Trulite Glass & Aluminum Solutions, LLC.
 10. Tubelite Inc.
 11. U.S. Aluminum; a brand of C.R. Laurence.
 12. Unitized Systems LLC.
 13. Vistawall International.
 14. Vitro America.
 15. Waltek & Company Limited.
 16. Wausau Window and Wall Systems; Apogee Wausau Group.
 17. YKK AP America, Inc.
- B. Framing Members: Extruded or formed aluminum framing members of thickness required and reinforced necessary to support imposed loads.
 1. Construction: Thermally broken.
 2. Glazing System: Retained mechanically with gaskets on two sides and structural sealant on two sides.
 3. Glazing Plane: Front.
 4. Finish: Baked enamel or powder coat finish.
 5. Color: Architect to select from manufacturer's full range.
 6. Fabrication Method: Factory fabricated unit and mullion system.

- C. Aluminum Curtain Wall System: Kawneer Co., Inc., 1600IR Wall System 2 or equivalent product from list of approved manufacturers:
 - 1. Structural Properties:
 - a. Limit the dead load deflection of horizontal members supporting glass to 1/175 of the clear span with a 1/8 inch maximum deflection.
 - b. Limit the deflection of any member in a direction parallel to the plane of the wall and of any corner mullion in both parallel and perpendicular directions to a maximum of 25 percent of the glass bite dimension and maintain a minimum of 1/8 inch clearance between the member and the edge of the glass, panel, or other component.
 - c. Limit the wind load deflection of any member to 1/240 plus 1/4 inch of the clear span, based on "pinned" ends.
 - d. Limit the wind load deflection of corner mullions to the span as specified above, with the specified pressure acting on one face of the building with no pressure acting on the adjacent face, or 1/2 the specified pressure acting on one face of the building with 1/2 the specified suction acting on the adjacent face, whichever is the greatest.
 - e. No wall element shall sustain permanent deflection of glass breakage under maximum design load.
 - f. The panels and their connections shall accommodate movements of the structure resulting from lateral forces. Provide connections with sufficient ductility to preclude brittle failure, at or near, welds.
- D. Framing Sizes: 2-1/2 inches x 7-13/16 inches where indicated on the drawings. Miter ends of horizontals to form segmented curve at commons
- E. Pressure Caps: Aluminum components that mechanically retain glazing with snap on aluminum trim that conceals fasteners.
- F. Brackets and Reinforcements: High strength aluminum with nonstaining, nonferrous shims for aligning system components.
- G. Materials:
 - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 - 2. Steel Reinforcement: Zinc rich, corrosion resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot Rolled Sheet and Strip: ASTM A 1011/A 1011M.
 - 3. Carbon Steel: ASTM A36.

2.2 ENTRANCES

- A. Entrance Doors: Glazed entrance doors for manual swing operation.
 - 1. Door Construction: 1-3/4 inch (44.5 mm) overall thickness, with minimum 0.125 inch (3.2 mm) thick, extruded aluminum tubular rail and stile members. Mechanically fasten

- corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - 2. Door Design: Nominal width of 6 inch (152.4 mm) vertical stiles and 6-1/2 inch (165.1 mm) bottom rail.
 - 3. Glazing Stops and Gaskets: Square, snap on, extruded aluminum stops and preformed gaskets.
- B. Entrance Door Hardware: Refer to Section 08 71 00 for aluminum entrance hardware sets.
- 1. Basis of Design: Series 500 Wide Stile, swing door standard as manufactured by Kawneer Co., Inc. or equivalent product from list of approved manufacturers.
 - 2. Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door to comply with requirements in this Section.
 - a. Opening-Force Requirements:
 - 1) Egress Doors: Maximum than 15 lbf 67 N to release the latch and not more than 30 lbf 133 N to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.
 - 2) Accessible Interior Doors: Maximum 5 lbf to fully open door.
 - b. Weather Stripping: Standard replaceable components to match existing.
 - c. Weather Sweeps: Standard exterior door bottom sweep with exposed fasteners on mounting strip to match existing.

2.3 GLAZING

- A. Glazing: Comply with Section 08 80 00.
- B. Glazing Gaskets: Comply with Section 08 80 00.
- C. Glazing Sealants: Recommended by manufacturer.
- D. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtainwall assembly indicated.
 - 1. Color: Architect to select color from manufacturer's full range.
- E. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural sealant, weatherseal sealant, and structural sealant glazed curtainwall manufacturers for this use.
 - 1. Color: Match structural sealant.

2.4 ACCESSORIES

- A. Fasteners and Accessories: Corrosion resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- B. Anchors: Three way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot dip galvanized cast iron, malleable iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Corrosion resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold applied asphalt mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.5 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Physical and thermal isolation of glazing from framing members.
 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 5. Provisions for field replacement of glazing from interior.
 6. Provisions for safety railings mounted on interior face of mullions.
 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
 8. Components curved to indicated radii.
- D. Fabricate components to resist water penetration:
 1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
 2. Pressure equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- E. Curtainwall Framing: Fabricate components for assembly using shear block system.
- F. Factory Assembled Frame Units:
 1. Rigidly secure nonmovement joints.
 2. Prepare surfaces that are in contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion.
 3. Preparation includes, but is not limited to, cleaning and priming surfaces.
 4. Seal joints watertight unless otherwise indicated.
 5. Install glazing to comply with requirements in Section 08 80 00.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 1. At exterior doors, provide weather stripping at fixed stops.
 2. At interior doors, provide weather stripping at stops to prevent metal to metal contact.
- H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide compression type weather stripping retained in adjustable strip and mortised into door edge.
 2. At exterior doors, provide weather sweeps applied to door bottoms.
- I. After fabrication, clearly mark components to identify locations according to Shop Drawings.

2.6 ALUMINUM FINISHES

- A. Baked Enamel or Powder Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: Selected by Architect.

2.7 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, adjoining construction, structural support, anchorage, and conditions for compliance with requirements for installation tolerances and conditions affecting performance of the work.
1. Verify rough opening dimensions, levelness of sill plate, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and built in components to ensure weathertight window wall installation.
 2. Notify Architect in writing, of dimensions, or conditions, found which prevent proper execution of the window wall work, including specified tolerances.
- B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. Coordinate installation with building enclosure work.
- B. Comply with manufacturer's written instructions for installing curtain wall, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.
1. Do not install damaged components.
 2. Fit frame joints to produce hairline joints free of burrs and distortion.
 3. Rigidly secure nonmovement joints.
 4. Remove loose particles present or resulting from fabrication or field cutting and drilling by blowing out joints with oil free compressed air, or by vacuuming joints.
 5. Remove protective coatings, oils from cutting and drilling operations, and residue on metallic surfaces with solvents that leave no residue.

6. Do not allow solvent to air dry without wiping. Use lint free towels for wiping of surfaces. Wipe metal surfaces with IPA (isopropyl alcohol) or xylene unless otherwise required by compatibility and adhesion testing results. Seal joints watertight. Clean excess joint sealants from finished surfaces.
 7. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 8. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 9. Seal joints watertight unless otherwise indicated.
 10. Set components within erection tolerances with uniform joints. Place components on shims and fasten to supporting substrates using bolts and similar fasteners.
 11. Do not erect components that are warped, deformed, bowed, dented, defaced, or damaged and impair strength or appearance. Remove and replace members damaged in process of erection.
 12. Coat concealed surfaces of dissimilar materials, and ferrous metal components, with heavy coating of bituminous paint, zinc rich primer or separation in accordance with manufacturer's recommendations. Where aluminum components will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 13. Do not burn, cut into or field drill holes or slots in building framing member without written acceptance of the structural engineer.
- C. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum is in contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- D. Entrance Doors and Hardware: Install doors to produce smooth operation and tight fit at contact points.
1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field Installed Entrance Door Hardware: Install surface mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- E. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- F. Install components plumb and true in alignment with established lines and grades.
- G. Permanently fasten to building structure with manufacturer recommended attachments and shims to permanently fasten system to building structure. Securely anchor components and units in place, allowing for required movement, including expansion and contraction. Set sill members in bed of sealant. Set other members with internal sealants and baffles to provide weathertight construction.
- H. Water Drainage: Compartmentalize each light of glass using joint plugs and silicone sealant to divert water to the horizontal weep locations. Locate weep holes in the horizontal pressure plates and covers to divert water to the exterior of the building.
- I. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather stripping contact and hardware movement to produce proper operation.
- J. Glazing: Install glazing gaskets and sealants in accordance with manufacturer's instructions without exception; including surface preparations. Refer to Section 088000.

1. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
- K. Insulation: Refer to Section 07 21 00.
- L. Weatherseal: Install weatherseal sealant according to Section 07 92 00 and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
 - c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
 4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.
 5. Tolerances are not accumulative.

3.5 FIELD QUALITY CONTROL

- A. The Owner reserves the rights to engage an independent testing and inspection agency to verify the adequacy of the Contractor's quality control. Obtain inspections from representative of the Owner's independent testing and inspection agency. Testing and inspecting agency will interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.
- C. Field Quality Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.
1. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of three tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
 2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Perform a minimum of three tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.

3. Water Penetration: ASTM E 1105 at a minimum static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.
- D. Structural Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, *Hand Pull Tab (Destructive)*, Appendix X2.
 1. Test a minimum of six areas on each building facade.
 2. Repair installation areas damaged by testing.
- E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Remove and replace noncomplying windows and retest as specified.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 CLEANING

- A. Clean metal surfaces promptly after installation, exercising care to avoid damage to factory finished exposed surfaces.
- B. Wash glass on both faces not more than 4 days prior to date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer. Remove excess glazing and sealant compounds, dirt, and other substances.
- C. Immediately remove deleterious material from surfaces of aluminum.

3.7 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that window wall Work will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 08 44 13

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Work under this section comprises of furnishing and installing hardware specified herein and noted on drawings for a complete and operational system, including any electrified hardware components, systems, controls and hardware for aluminum entrance doors. Any door shown on the drawing and not specifically referenced in the hardware sets shall be provided with identical hardware as specified on other similar openings and shall be included in the finish hardware suppliers bid. All fire rated door shall be provided with fire rated hardware as required by local code Authority as part of the hardware supplier's base bid. The hardware supplier shall verify all cylinder types specified for locking devices supplied as part of the door system with the door manufacturer and/or door supplies.
- B. The General Contractor shall notify the Architect in writing of any discrepancies (five (5) days prior to bid date) that could and/or would result in hardware being supplied that is none functional, hardware specified and/or hardware that has not been specified that will result in any code violations and any door that is not covered in this specification. Failure of the general contractor to address any such issue shall be considered acceptance of the hardware specified and all discrepancies shall be corrected at the general contractor's expense and considered as being a part of their base bid. Change orders shall not be issued if, deemed by the Architect and/or Pharr San Juan Alamo ISD to fall under and/or be covered as a part of the general contractor's base bid, due to failure to comply with this instruction notification.
- C. Items include but are not limited to the following:
 - 1. Hinges - Pivots
 - 2. Flush Bolts
 - 3. Exit Devices
 - 4. Locksets and Cylinders
 - 5. Push Plates - Pulls
 - 6. Coordinators
 - 7. Closers
 - 8. Kick, Mop and Protection Plates
 - 9. Stops, Wall Bumpers, Overhead Controls
 - 10. Electrified Hold Open Devices
 - 11. Thresholds, Seals and Door Bottoms
 - 12. Silencers
 - 13. Miscellaneous Trim and Accessories

1.02 RELATED DOCUMENTS, drawings and general provisions of contract, including General and Supplementary Conditions, and Division 1 Specification sections, apply to this section.

1.03 RELATED WORK specified elsewhere that should be examined for its effect upon this section:

- A. Section 06 20 00 - Finish Carpentry
- B. Section 08 11 13 – Steel Doors and Frames
- C. Section 08 14 16 – Flush Wood Doors
- D. Sections within 08 31 13 – Access Doors
- E. Section within 08 41 13 – Aluminum Entrances, Storefront and Window Framing
- F. Sections within 08 80 00 – Glass and Glazing
- G. Sections within 09 91 00 - Painting
- H. Division 26 – Electrical

I. Division 28 – Access Control

1.04 REFERENCES SPECIFIED in this section subject to compliance as directed:

- A. NFPA-80 - Standard for Fire Doors and Windows
- B. NFPA-101 - Life Safety Code
- C. ADA - The Americans with Disabilities Act - Title III - Public Accommodations
- D. ANSI-A 117.1 - American National Standards Institute - Accessible and Usable Buildings and Facilities
- E. ANSI-A 156.5 - American National Standards institute -Auxiliary Locks and Associated Products
- F. UFAS - Uniform Federal Accessibility Standards
- G. UL – Under-writer’s Laboratories
- H. WHI - Warnock Hersey International, Testing Services
- I. State and Local Codes including Authority Having Jurisdiction
- J. UL10C – Positive Pressure
- K. IBC-2015 – International Building Code
- L. NFPA-70 – International Electrical Code

1.05 SUBMITTALS

- A. HARDWARE SCHEDULES submit copies of schedule in accordance with Division 1, General Requirements. Schedule to be in vertical format, listing each door opening, including: handing of opening, all hardware scheduled for opening or otherwise required to allow for proper function of door opening as intended, and finish of hardware. At doors with door closers or door controls include degree of door opening. Supply the schedules all Finish Hardware within two (2) weeks from date purchase order is received by the hardware supplier.
- B. Submit manufacturer’s cut/catalog sheets on all hardware items and any required special mounting instructions with the hardware schedule.
- C. Certification of Compliance:
 - 1. Submit any information necessary to indicate compliance to all these specifications as required.
 - 2. Submit a statement from the manufacturer that electronic hardware and systems being supplied comply with the operational descriptions exactly as specified.
- D. Submit any samples necessary as required by the Architect.
- E. Templates for finish hardware items to be sent to related door and frame suppliers within three working days of receipt of approved hardware schedule.
- F. Doors and Frames used in positive pressure opening assemblies shall meet UL10C in areas where this specification includes Seals for smoke door.

1.06 QUALITY ASSURANCE

- A. Hardware supplier to be a qualified, Factory Authorized, direct distributor of the products to be furnished. In addition, the supplier to have in their regular employment an A.H.C. or person of equivalent experience who will be made available at reasonable times to consult with the Architect/Contractor and/or PSJA regarding any matters affecting the finish hardware on this project.

- B. All hardware used in labeled fire or smoke rated openings to be listed for those types of openings and bear the identifying label or mark indicating UL. (Under-writer's Laboratories) approved for fire. Exit devices in non-labeled openings to be listed for panic.

1.07 DELIVERY, HANDLING AND PACKAGING

- A. Furnish all hardware with each unit clearly marked and numbered in accordance with the hardware schedule. Include door and item number for each.
- B. Pack each item of hardware completes with all necessary parts and fasteners.
- C. Properly wrap and cushion each item to prevent scratches and dents during delivery and storage.

1.08 SEQUENCING AND SCHEDULING

Any part of the finish hardware required by the frame or door manufacturers or other suppliers that is needed to produce doors or frames is to be sent to those suppliers in a timely manner, so as not to interrupt job progress.

1.09 WARRANTY

- A. All finish hardware shall be supplied with a Two- (2) year warranty against defects in materials and workmanship, commencing with substantial completion of the project except as follows:
 - 1. All Closers are to have a thirty- (30) year written warranty.
 - 2. All Exit Devices are to have a three- (3) year written warranty.
 - 3. All Locksets are to have a three- (3) year written warranty.
- B. Upon conclusion of the Manufactures standard written warranty, the Hardware Supplier shall be liable for the balance of the extended warranty periods specified.

PART 2 – PRODUCTS

2.01 FASTENERS

- A. Furnish with finish hardware all necessary screws, bolts and other fasteners of suitable size and type to anchor the hardware in position for a long life under hard use.
- B. Furnish fastenings where necessary with expansion shields, toggle bolts and other anchors designated by the Architect according to the material to which the hardware is to be applied and the recommendations of the hardware manufacturer. All closers and exit devices on labeled wood doors shall be through-bolted if required be the door manufacturer. All thresholds shall be fastened with wood screws and plastic anchors. Where specified in the hardware sets, security type fasteners of the type called for are to be supplied.
- C. Design of all fastenings shall harmonize with the hardware as to material and finish.
- D. All hardware shall be installed with the Manufacturers standard screws as provided. The use of any other type of fasteners shall not be permitted.

2.02 ENVIRONMENTAL CONCERN FOR PACKAGING

Hardware shipped to the project job site shall be packaged in biodegradable packs such as paper or cardboard boxes and wrapping.

2.03 HINGES

- A. All hinges to be of one manufacturer as hereafter listed for continuity and consideration of warranty. Provide one of the following manufacturers Ives, Hager or Stanley products as specified and/or listed below.
- B. Unless otherwise specified provide ball bearing five-knuckle, heavy-duty, button tip, full mortise template type hinges with non-rising loose pins. Provide non-removable pins for out swinging doors at secured areas or as called for in this specification (Refer to 3.02 Hardware Sets).
- C. Exterior and interior five knuckle Ball Bearing door hinges shall be manufactured from solid stainless steel or bronze base metal. Furnish three (3) hinges up to 90 inches high and one (1) additional hinge for every 30 inches or fraction thereof. Provide all out-swinging doors with non-removable pins or security studs as called for in 3.02 Hardware Sets.
- D. Provide all exterior & interior hinges in a size 4½" x 4½" for all 1¾" thick doors up to and including 36 inches wide. Doors over 1¾" through 2¼" thick, use 5" x 5" hinges. Doors over 36 inches use 5" x 4½" unless otherwise noted in 3.02 Hardware Sets.
- E. Were exterior or interior door hinges are required to clear the trim and/or to permit the doors to swing 180 degrees furnish hinges of sufficient throw.
- F. Provide heavy weight hinges on all exterior or interior doors over 36 inches in width.
- G. At exterior or interior labeled door's ball-bearing steel or stainless-steel type hinges shall be provided. For all doors equipped with closers provide ball-bearing-type hinges.
- H. Finishes at all Interior and Exterior door hinges shall be brushed stainless-steel or dull chrome, unless otherwise specified in 3.02 Hardware Sets.
- I. Continuous hinges shall not be used or accepted on any PSJA project.

2.04 LOCK AND LOCK TRIM

- A. All locksets, latch sets, and trim to be of one manufacturer as hereafter listed for continuity of design and consideration of warranty. Provide Locks and Latch sets as specified for matching the existing district key systems (established in 2012) and security locking standards. All locks specified shall be the Falcon "T" series with the "Dane" lever and shall be prep for small format seven (7) pin interchangeable cores.
- B. Provide metal wrought box strike boxes and curved lip strikes with proper lip length to protect trim of the frame, but not to project more than 1/8 inch beyond frame trim or the inactive leaf of a pair of doors.
- C. Mechanical Locks shall meet ANSI Operational Grade 1, Series 4000 as specified.
 - 1. Hand of lock is to be field reversible and/or non-handed.
 - 2. All lever trim is to be through-bolted through the door.
 - 3. All pairs of doors shall be provided with a ¾" latch bolt throw.
 - 4. Provide extended 5" backsets at all doors specified with sound seal that would conflict with lock or seal installation.
 - 5. Provide all Classrooms and/or areas in which student gather with the Security Classroom Function Locks.
 - 6. Provide all IDF and MDF rooms with Schlage Electronic Access Control Lock #AD-200-CY-70- MTK-RHO-BD-8B to match current district standards.
 - 7. Provide Padlocks and/or Cylinders as required for all Gates, Wire Mesh Partition Doors, Folding Partition Doors, Overhead Doors and Coiling Overhead Counter Doors shown. All

Padlocks and Cylinders shall be Factory keyed to the Existing PSJA Grand Master Key System established in 2012.

- D. Provide locks as specified unless prior written approval for products manufactured by Sargent or Best is granted per the General Conditions section of the specifications.

A.05 CYLINDERS AND KEYING

- A. Provide locks and Exit devices requiring cylinders with Falcon Seven (7) pin Interchangeable core cylinders and comply with performance requirements of ANSI A156.5. All keys shall be of nickel silver material only. All locks are to be factory keyed to the Existing Falcon Grand Master Key system as directed by Pharr San Juan Alamo ISD and the Architect. The hardware supplier shall meet with the General Contractor, Architect and Pharr San Juan Alamo ISD at the project site to determine all permanent keying requirements. Provide Falcon permanent cores, "No Substitution".
- B. The hardware supplier shall provide the following items to the Pharr San Juan Alamo ISD district locksmith for future use (Signature for all items shall be required).
- 1) Two Hundred- (200) extra key blanks KB628 (7 Pin) & stamped as required by Pharr San Juan Alamo ISD.
 - 2) Forty (40) uncombined cores #C647.
 - 3) Provide a copy of the bitting list used for each project with expansion as required by Pharr San Juan Alamo ISD to the district locksmith prior to installation of permanent cores. The bitting list shall be emailed to the district locksmith at the following email address: jorge.garcia@psjaisd.us.
 - 4) One (1) Knox Box as required by the local Fire Marshall. The contractor shall as require by the local Fire Marshall and Pharr San Juan Alamo ISD install the Knox Box.
 - 5) Six (6) Large Bow Emergency Keys for each Indicator Deadlock specified.
 - 6) Two (2) Dogging Keys for each None Fire Rated Panic Exit Device specified.
- C. Furnish all locks, cylinders and Exit devices with temporary keyed construction cores for the duration of construction. Provide ten (10) construction keys and two (2) construction control keys total. The general contractor shall within thirty (30) days of the installation of permanent cores return all construction cores to the hardware supplier for full credit. Permanent cores shall be installed by the hardware supplier.
- D. Cylinders shall be factory keyed as directed by Pharr San Juan Alamo ISD and the Architect. Provide three- (3) keys per cylinder and six- (6) master keys per master used. Deliver all Permanent Keys and Cores to the Pharr San Juan Alamo ISD to the district locksmith individually tagged by key symbol and door number.
- E. Factory stamp all keys "Do not duplicate" and with key symbol as directed by Pharr San Juan Alamo ISD. Factory concealed visual key control (stamp all permanent cores with the key symbol on the side of the core). Engraved cores will be rejected.

2.06 EXIT DEVICES

- A. All exit devices and trim, including electrified items, to be of one manufacturer as hereafter listed and in the hardware sets for continuity of design and consideration of warranty; electrified devices and trim to be the same series and design as mechanical devices and trim.
- B. Exit Devices to be "UL" listed for life safety. All exit devices for labeled doors shall have "UL" label for "Fire Exit Hardware". All devices mounted on labeled wood doors are to be through-bolted or installed per the manufacturer's listing requirements. All devices shall conform to NFPA 80 and NFPA 101 requirements.

- C. All exit devices to be of a heavy duty, chassis mounted design, with one-piece removable covers, eliminating necessity of removing the device from the door for standard maintenance and keying requirements.
- D. All trims to be through-bolted to the lock stile case. Lever design "Dane #06" to be the same as specified with the lock sets. Provide Two (2) Dogging Keys for each none fire rated Panic Exit Device. Dogging Keys are to be turned over to the Pharr San Juan Alamo ISD district locksmith prior to project completion.
- E. Exit Devices to be the modern push rail design. Exit Devices supplied shall be capable of being field modified to receive a standard factory Electric Latch Retraction "EL" or Request to Exit "RX" Kit, as manufactured by Von Duprin, Inc.
- F. All devices shall carry a three- (3) year warranty against manufacturing defects and workmanship.
- G. Exit Devices being used on Aluminum Storefront doors shall be the "99" series Rim Exit Devices with Key Removable Mullions when required. Concealed Vertical Rod Exit Devices shall not be accepted and/or allowed for use on any Pharr San Juan Alamo ISD project. Provide Exit Devices only as required by code (NFPA-70, National Electrical Code) at the Electrical Room egress doors.
- H. Exit Devices shall be Von Duprin "99" series with "990NL or 990DT" pull series trim at exterior doors and "996L" breakaway lever series trim at interior doors as specified and manufactured by Von Duprin. All Exit Devices shall match the Current District Standards for Security & Egress Hardware. Provide all Classrooms and/or areas in which student gather that require Panic Hardware for egress with the Security Locking Function (Von Duprin suffix -2).
- I. Provide Von Duprin as specified unless prior written approval for products manufactured by Sargent or Precision is granted per the General Conditions section of the specifications.

2.07 SURFACE MOUNTED DOOR CLOSERS

- A. All closers for this project shall be the products of a single manufacturer for continuity of design and consideration of warranty. All door closers shall be mounted as to achieve the maximum degree of opening (trim permitting).
- B. All closers shall be heavy duty, surface-mounted, fully hydraulic, rack and pinion action with a high strength cast iron cylinder to provide control throughout the entire door opening and closing cycle.
- C. Size all closers in accordance with the manufacturer's recommendations at the factory.
- D. All closers to have adjustable spring power sizes 1 or 2 through 4 or 6 and separate tamper resistant, brass, non-critical regulating screw valves for closing speed, latching speed and back-check control as a standard feature unless specified otherwise.
- E. All exterior closer covers to be rectangular cover type of non-ferrous, non-corrosive material painted to match closer.
- F. Closers shall have heavy-duty arms. All closer arms shall be of sufficient length to accommodate the reveal depth and to insure proper installation. The hardware supplier shall provide all required brackets, spacers or filler plates as required by the manufacture for a proper and functional installation as part of their base bid.

- G. Supply appropriate arm assembly for each closer so that closer body and arm are mounted on non-public side of door opening and on the interior side of exterior openings, except where required otherwise in the hardware sets.
 - 1. All parallel arm mounted closers to be factory indexed to insure proper installation.
 - 2. Furnish heavy-duty cold forged parallel arms for all parallel arm mounted closers.
- H. Provide closers with special application and heavy-duty arms as specified in the hardware sets or as otherwise called for to insure a proper operating, long lasting opening. Drop plates and any additional brackets required for the proper installation of the door closer shall be included in the hardware supplier's base bid. Install all door closers with SNB.
- I. Finish: Sprayed enamel finish shall match other hardware.
- J. Provide LCN 4040XP closers on exterior doors and LCN 1461 closers on interior doors as specified unless prior written approval for products manufactured by Corbin Russwin is granted per the General Conditions section of the specifications.

2.08 DOOR STOPS AND HOLDERS

- A. Door stops are to be furnished for every door leaf. Every door is to have a floor, wall, or an overhead stop.
- B. Place doorstops in such a position that they permit maximum door swing, but do not present a hazard of obstruction. Furnish floor strikes for floor holders of proper height to engage holders of doors.
- C. Where overhead stops and holders are specified, or otherwise required for proper door operation, they are to be heavy duty and of extruded brass, bronze or stainless steel with no plastic parts as specified. The General Contractor shall provide wood blocking in all stud walls specified and scheduled to receive wall stops.
- D. Finish: Same as other hardware where available.
- E. Acceptable Products
 - 1. Floor and wall stops as listed in hardware sets. Equivalent products as manufactured by Ives, Rockwood, ABH, Glynn Johnson and Trimco are acceptable.

2.09 PUSH PLATES, DOOR PULLS, AND KICKPLATES

- A. All push plates, door pull, kick plates and other miscellaneous hardware as listed in hardware sets. Equivalent products as manufactured by Ives, Rockwood, Hager and Trimco are acceptable.
- B. Kick plates to be 10 inches high and Mop plates to be 6 inches high, both by 2 inches or 1 inch less than door width (LDW) as specified. They are to be of 16-gauge thick stainless steel. For door with louvers or narrow bottom rails, kick plate height to be 1 inch less dimension shown from the bottom of the door to the bottom of the louver or glass.
- C. Where required armor plates, edge guards and other protective hardware shall be supplied in sizes as scheduled in the hardware sets.
- D. Finish: Same as other hardware where available.

2.10 FLUSH BOLTS AND COORDINATORS

- A. Provide Flush bolts with Dust Proof Strikes as indicated in the individual hardware sets by Ives, Rockwood, ABH, Hager and Trimco are acceptable. Finish shall match the adjacent hardware.

2.11 THRESHOLDS AND SEALS

- A. Provide materials and finishes as listed in hardware sets as manufactured by Zero. Equivalent product by National Guard Products and Reese are acceptable. All thresholds must be in accordance with the requirements of the ADA and ANSI A117.1.
- B. Provide thresholds with wood screws and plastic anchors. Supply all necessary anchoring devices for weather strip and sound seal.
- C. Seals shall comply with requirements of UL10C. All thresholds, door bottoms and weather strip inserts shall be a silicone-based product as specified in 3.02 Hardware Sets.
- D. Seals shall comply with the requirements of the Wood Door Manufacturer's certification requirements.
- E. Provide all Threshold with none slip coating as specified.

2.12 FINISHES

- A. Finishes for all hardware are as required in this specification and the hardware sets.
- B. Special care is to be taken to make uniform the finish of all various manufactured items.

2.13 DOOR SILENCERS

- A. Provide door silencers at all openings without gasket. Provide two- (2) each at each pair of doors and three- (3) or four- (4) each for each single door (coordinate with the frame manufacturer).

2.14 KEY CABINET

- A. Provide a Lund key cabinet #1200 series with 150% expansion for installation by the contractor as instructed by the Architect. The hardware supplier shall (on the project site) assist and train the Pharr San Juan Alamo ISD staff in the proper use of the key cabinet. This shall include the tagging of all keys, instructing the Pharr San Juan Alamo ISD staff as to the proper use of the key cabinet and how they can best maintain the key system. The hardware supplier shall provide two- (2) copies of the floor plans that show the door number and key symbol at each door opening. One- (1) copy shall be placed in the key cabinet and one- (1) copy shall be turned over to the facilities locksmith. The hardware supplier shall send the Architect written confirmation that this has been completed. Confirmation shall include the date training occurred and names of all Pharr San Juan Alamo ISD staff members trained.

2.15 PROPRIETARY PRODUCTS

- A. References to specific products are used to establish quality standards of utility and performance. Unless otherwise approved provide only the specified product.
- B. All other materials, not specifically described, but required for a complete and proper finish hardware installation, are to be selected by the Contractor, subject to the approval of the Architect and Pharr San Juan Alamo ISD.

- C. Architect and Pharr San Juan Alamo ISD reserve the right to approve all the substitutions proposed for this specification. All requests for substitution to be made prior to bid in accordance with Division 1, General Requirements, and are to be in writing, hand delivered to the Architect. Two (2) copies of the manufacturer's brochures and a physical sample of each item in the appropriate design and finish shall accompany requests for substitution.

PART 3 - EXECUTION

3.01 INSTALLATION OF FINISH HARDWARE

- A. All finish hardware shall be installed by an experienced finish hardware installer with at least ten (10) years experience after a pre-installation meeting between the contractor, hardware Manufacturers representative, the hardware supplier, the hollow metal supplier and the wood door supplier. The finish hardware installer shall be responsible for the proper installation and function of all doors and hardware.
- B. Check hardware against the reviewed hardware schedule upon delivery. Store the hardware in a dry and secure location to protect against loss and damage.
- C. Install finish hardware in accordance with approved hardware schedule and manufacturers' printed instructions. Pre-fit hardware before finish is applied to door; remove and reinstall after finish is complete and dry. Install and adjust hardware so that parts operate smoothly, close tightly, and do not rattle.
- D. Mortise and cutting to be done neatly, and evidence of cutting to be concealed in the finished work. Protect all Finish hardware from scratching or other damage.
- E. The hardware supplier, general contractor, hardware installer, representatives of the lock, exit device and closer manufacturers shall after three (3) months of Pharr San Juan Alamo ISD acceptance of the facility perform an onsite survey of the finish hardware installation. Any item of finish hardware found to be defective or out of adjustment shall be replaced or adjusted for the proper function and operation of the door assembly at the contractor's, supplier's and/or installer's expense. The hardware supplier shall provide a written report of all affected items to the Architect and Pharr San Juan Alamo ISD Facilities Department.

3.02 HARDWARE SETS:
HARDWARE GROUP NO. 103S

For use on Door #(s):

110-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|----------------|------------------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | | 630 | IVE |
| 1 | EA | OFFICE LOCK | T521HD7 DANE ¾" | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | SURFACE CLOSER | 4040XP SCUSH SRI | | 689 | LCN |
| 1 | EA | THRESHOLD | 65A-FRAME WIDTH | | A | ZER |
| 1 | EA | DOOR BOTTOM | 50MA-DOOR WIDTH (PULL SIDE MTG) | | A | ZER |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |

HARDWARE GROUP NO. 201-10

For use on Door #(s):

114-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|------------------|----------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | | 630 | IVE |
| 1 | EA | CYLINDRICAL LOCK | AD-200-CY-70-MTK-RHO-BD-8B | | 626 | SCH |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | SURFACE CLOSER | 1461 PA SRI | | 689 | LCN |
| 1 | EA | DOOR STOP | WS402CCV/FS436 (AS REQ'D) | | 626 | IVE |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |

HARDWARE GROUP NO. 210

For use on Door #(s):

108-1

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|----------------|-------------------------------------|--------|--------|-----|
| 6 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | | 630 | IVE |
| 2 | EA | SURFACE BOLT | SB360-12 | | 604 | IVE |
| 1 | EA | STOREROOM LOCK | T581HD7 DAN ¾" THROW | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 2 | EA | SURFACE CLOSER | 4040XP SHCUSH SRI | | 689 | LCN |
| 2 | EA | WALL STOP | WS406/407CCV | | 630 | IVE |
| 1 | EA | ASTRAGAL | 43SP-DOOR HEIGHT (PULL SIDE MTG) | | SP | ZER |
| 1 | EA | THRESHOLD | 65A-FRAME WIDTH | | A | ZER |
| 1 | EA | DOOR BOTTOM | 50MA-DOOR WIDTH (PULL SIDE MTG) | | A | ZER |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |

HARDWARE GROUP NO. 214C

For use on Door #(s):

111-1

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|-----|----------------|-------------------------------------|--------|--------|-----|
| 6 | EA | HINGE | 5BB1HW 4.5 X 4.5 | | 630 | IVE |
| 2 | EA | SURFACE BOLTS | SB360-12" | | 604 | IVE |
| 1 | EA | CLASSROOM LOCK | T581HD7 DAN ¾" THROW | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 2 | EA | SURFACE CLOSER | 4040XP REG SRI | | 689 | LCN |
| 2 | EA | FLOOR STOPS | FS18BK | | BK | IVE |
| 1 | SET | WEATHER STRIP | 8303AA-PSA-HEAD & JAMBS | | AA | ZER |
| 1 | EA | RAIN DRIP | 142A FRAME WIDTH + 4" | | AA | ZER |
| 1 | EA | ASTRAGAL | 905A-DOOR HEIGHT (PUSH SIDE MTG) | | A | ZER |
| 2 | EA | DOOR SWEEP | 50MA-DOOR WIDTH (PUSH SIDE MTG) | | A | ZER |
| 1 | EA | THRESHOLD | 546A-FRAME WIDTH | | A | ZER |

HARDWARE GROUP NO. 214CA

For use on Door #(s):

111A-1

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|-----|----------------|-------------------------------------|--------|--------|-----|
| 6 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | | 630 | IVE |
| 2 | EA | SURFACE BOLTS | SB360-12" | | 604 | IVE |
| 1 | EA | STOREROOM LOCK | T581HD7 DAN ¾" THROW | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 2 | EA | SURFACE CLOSER | 4040XP SCUSH SRI | | 689 | LCN |
| 1 | SET | WEATHER STRIP | 8303AA-PSA-HEAD & JAMBS | | AA | ZER |
| 1 | EA | RAIN DRIP | 142A-FRAME WIDTH + 4" | | AA | ZER |
| 1 | EA | ASTRAGAL | 43SP-DOOR HEIGHT (PULL SIDE MTG) | | AA | ZER |
| 2 | EA | DOOR SWEEP | 50MA-DOOR WIDTH (PULL SIDE MTG) | | A | ZER |
| 1 | EA | THRESHOLD | 65A-FRAME WIDTH | | A | ZER |

HARDWARE GROUP NO. 215S

For use on Door #(s):

111B-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|-----|----------------|------------------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | | 630 | IVE |
| 1 | EA | STOREROOM LOCK | T581HD7 DAN ¾" THROW | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | SURFACE CLOSER | 4040XP SHCUSH SRI | | 689 | LCN |
| 1 | SET | WEATHER STRIP | 8303AA-PSA-HEAD & JAMBS | | AA | ZER |
| 1 | EA | RAIN DRIP | 142A FRAME WIDTH + 4" | | AA | ZER |
| 1 | EA | DOOR SWEEP | 50MA-DOOR WIDTH (PULL SIDE MTG) | | AA | ZER |
| 1 | EA | THRESHOLD | 65A-FRAME WIDTH | | A | ZER |

HARDWARE GROUP NO. 343S

For use on Door #(s):

110A-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|-----|-----------------------|------------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | | 630 | IVE |
| 1 | EA | PASSAGE SET | T101S DAN | | 626 | FAL |
| 1 | EA | INDICATOR DEADLOCK | D271 X (6) EMERGENCY KEYS | | 626 | FAL |
| 1 | EA | SURFACE CLOSER | 1461 REG SRI | | 689 | LCN |
| 1 | EA | FLOOR STOP | FS18BK | | BK | IVE |
| 1 | SET | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |

HARDWARE GROUP NO. 503

For use on Door #(s):

105-1

107-1

109-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|-------------------|------------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NPR | | 630 | IVE |
| 1 | EA | STOREROOM LOCK | T581HD7 DAN | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | WALL STOP | WS406/407CCV | | 630 | IVE |
| 1 | EA | DOOR SWEEP | 50MA-DOOR WIDTH | | A | ZER |
| 1 | EA | THRESHOLD | 546A-FRAME WIDTH | | A | ZER |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |

HARDWARE GROUP NO. 503S

For use on Door #(s):

103-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|----------------|---------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | | 630 | IVE |
| 1 | EA | CLASSROOM LOCK | T561HD7 DAN | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | SURFACE CLOSER | 4040XP REG SRI | | 689 | LCN |
| 1 | EA | WALL STOP | WS406/407CCV | | 630 | IVE |
| 1 | EA | DOOR SWEEP | 50MA-DOOR WIDTH | | A | ZER |
| 1 | EA | THRESHOLD | 546A-FRAME WIDTH | | A | ZER |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |

HARDWARE GROUP NO. 801

For use on Door #(s):

101-1

102-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|------------------|---------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | | 630 | IVE |
| 1 | EA | DEADLOCK | D111HD | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | PULL PLATE | 8305-F 8" 4"X16" | | 630 | IVE |
| 1 | EA | PUSH PLATE | 8200 8" X 16" | | 630 | IVE |
| 1 | EA | SURFACE CLOSER | 4040XP PA SRI | | 689 | LCN |
| 1 | EA | PROTECTION PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | | 630 | IVE |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |
| 1 | EA | THRESHOLD | 65A-FRAME WIDTH | | A | ZER |
| 1 | EA | DOOR BOTTOM | 50MAA-DOOR WIDTH | | AA | ZER |

HARDWARE GROUP NO. 801A

For use on Door #(s):

104-1 106-1

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|------------------|---------------------------|--------|--------|-----|
| 3 | EA | HINGE | 5BB1HW 4.5 X 4.5 | | 630 | IVE |
| 1 | EA | DEADLOCK | D111HD | | 626 | FAL |
| 1 | EA | SFIC CORE | C607 VKC | | 626 | FAL |
| 1 | EA | PULL PLATE | 8305-F 8" 4"X16" | | 630 | IVE |
| 1 | EA | PUSH PLATE | 8200 8" X 16" | | 630 | IVE |
| 1 | EA | SURFACE CLOSER | 4040XP REG SRI | | 689 | LCN |
| 1 | EA | PROTECTION PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | | 630 | IVE |
| 1 | EA | GASKETING | 8145S-BK-PSA-HEAD & JAMBS | | BK | ZER |
| 1 | EA | THRESHOLD | 546A-FRAME WIDTH | | A | ZER |
| 1 | EA | DOOR BOTTOM | 50MAA-DOOR WIDTH | | AA | ZER |

HARDWARE GROUP NO. 801AA (GATES WITH PADLOCKS)

For use on Gates #(s):

SITE GATES

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|-------------|-----------------------------|--------|--------|-----|
| 1 | EA | PADLOCK | KS41 (2"/4" SHACKLE AS REQ) | | | FAL |
| 1 | EA | SFIC CORE | C647 CKC | | | FAL |

HARDWARE GROUP NO. 801AB (GATES WITH EXTERIOR PANIC HARDWARE)

For use on Gates #(s):

EXIT GATES

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|---------------|----------------|--------|--------|-----|
| 1 | EA | PUSH PAD EXIT | 99-EO-WH-SEC | | 628 | VON |
| | | DEVICE | | | | |
| 1 | EA | SFIC CORE | C647 CKC | | | FAL |

HARDWARE GROUP NO. EXTRA (OWNERS STOCK)

For use on Door #(s):

001

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|--------------|----------------|--------|--------|-----|
| 40 | EA | SFIC CORE | C647 CKC | | 626 | FAL |
| 200 | EA | IC KEY BLANK | KB628 | | | FAL |

HARDWARE GROUP NO. FRP714

For use on Door #(s):

113-1 115-1

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | ITEMID | FINISH | MFR |
|-----|----|--------------------------|---|--------|--------|-----|
| 6 | EA | HINGE | 5BB1HW 5 X 4.5 NRP | | 630 | IVE |
| 1 | EA | KEY REMOVABLE MULLION | KR9954-B-154 | | 689 | VON |
| 1 | EA | PANIC HARDWARE | HH-99-NL | | 628 | VON |
| 1 | EA | PANIC HARDWARE | HH-99-DT | | 628 | VON |
| 1 | EA | MORTISE CYLINDER | C987 008876-001 X 1/4' BLOCKING RING | | 626 | FAL |
| 1 | EA | SFIC RIM CYLINDER | C953-CCA | | 626 | FAL |
| 2 | EA | SFIC CONST. CORE | C607CCA | | 622 | FAL |
| 2 | EA | SFIC CORE | C607 CKC | | 626 | FAL |
| 2 | EA | SURFACE CLOSER | 4040XP SCUSH SRI | | 689 | LCN |
| 1 | EA | MEETING STILE | 8194AA-2 PCS DOOR HEIGHT (PULL SIDE MTG) | | AA | ZER |
| 1 | EA | GASKETING | 8303AA -PSA-HEAD & JAMBS | | AA | ZER |
| 1 | EA | RAIN DRIP | 142A DW + 4" | | AA | ZER |
| 2 | EA | DOOR SWEEP | 50MA-DOOR WIDTH | | AA | ZER |
| 1 | EA | THRESHOLD | 65A-FRAME WIDTH | | A | ZER |

END OF SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Float glass.
 - 2. Tempered glass.
 - 3. Insulated glass.
 - 4. Laminated glass.
 - 5. Glazing sealants.
 - 6. Accessories necessary for a complete installation.

1.3 DEFINITIONS

- A. Glass Thickness: Indicated by thickness designations in millimeters according to ASTM C 1036.
- B. Interspace: Space between lites of an insulating glass unit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design glass panels including comprehensive engineering analysis by a qualified professional engineer lawfully licensed in the State of Texas, using performance requirements and design criteria indicated.
- B. Installed Glazing: Design glazing systems to withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. Design Wind Pressures: Indicated on Drawings.
 - 2. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
 - a. Wind Design Data: As indicated on Drawings.
 - b. Basic Wind Speed: [85 mph (38 m/s)] [90 mph (40 m/s)] [100 mph (44 m/s)] [110 mph (49 m/s)].
 - c. Importance Factor: 1.0.
 - 3. Exposure Category: C.
 - 4. Design Snow Loads: Indicated on Drawings.
 - 5. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
 - 6. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

7. Maximum Lateral Deflection: For glass supported on all four edges, limit center of glass deflection at design wind pressure to not more than 1/50 times the short side length or 1 inch (25 mm), whichever is less.
- D. Windborne Debris Impact Resistance: Exterior glazing shall comply with protection testing requirements in ASTM E 1996 for Wind Zone 2 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on Project and shall be installed in same manner as glazing indicated for use on Project.
 1. Large Missile Test: For glazing located within 30 feet (9.1 m) of grade.
 2. Small Missile Test: For glazing located more than 30 feet (9.1 m) above grade.
- E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 1. For monolithic glass lites, properties are based on units with lites 6 mm thick.
 2. For laminated glass lites, properties are based on products of construction indicated.
 3. For insulating glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center of glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 5. Solar Heat Gain Coefficient and Visible Transmittance: Center of glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

1.5 SUBMITTALS

- A. Product Data: Technical data for each type of product including recommended installation and cleaning procedures.
- B. Glass Samples: For each type of glass required. Prepare samples from same material to be used for Work.
- C. Glazing Schedule: List glass types and thickness for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Product Certificates: Submit glass product certificates required by Code.
 1. Glass Manufacturer Certificate: The glass manufacturer shall submit a letter certifying it has reviewed the glazing details proposed for the project, including the use of gaskets and sealants, and that each product furnished is recommended for the application shown and compliance with the Code.
- F. Thermal Stress and Wind Load Analyses: Submit the following from the glass manufacturer:
 1. Thermal stress analysis for each exterior glass unit type, each building elevation. The analysis shall clearly indicate the expected service temperature ranges and the effects of partial and full shading on the glass.
 - a. Attach to the thermal stress analysis a statement from the glass manufacturer that based upon this analysis that the resulting thermal stresses will not reduce the specified statistical probability of breakage.

2. Wind load analysis for each glass unit type, each building elevation. The analysis shall indicate the statistical probability of breakage at the design wind pressure does not exceed the specified statistical probability of breakage.
- G. Product Test Reports: Submit test reports for insulating glass and glazing sealants, for tests performed by a qualified testing agency.
1. Glazing Sealants: Provide test reports based on testing current sealant formulations within previous 36 month period.
 2. Glazing Sealants: Preconstruction adhesion and compatibility test report.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Building Code: Comply with applicable requirements of the IBC for glazing.
 2. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
 - a. As a minimum provide Category II materials complying with testing requirements in 16 CFR 1201 (Consumer Product Safety Commission *Safety Standard for Architectural Glazing Materials*, published in the Code of Federal Regulations) and ANSI Z97.1.
 - b. Permanently mark safety glass with certification label of Safety Glazing Certification Council.
 3. Insulating Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
 4. Glazing Publications: Comply with published recommendations of glass product organizations.
 - a. GANA: Glazing Manual.
 - b. IGMA: SIGMA TM-3000 Vertical Glazing Guidelines.
 - c. GANA: Laminated Glazing Reference Manual.
 - d. AAMA: AAMA GDSG-1 Glass Design for Sloped Glazing.
 - e. AAMA: TIR A7 Sloped Glazing Guidelines.
 - f. IGMA for Sloped Glazing: IGMA TB-3001 Guidelines for Sloped Glazing.
 - g. IGMA for Insulating Glass: SIGMA TM-3000 North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use.
 5. Fire Rated Door Assemblies: Assemblies complying with NFPA 80 listed and labeled by UL for fire ratings indicated, based on testing according to NFPA 252.
 6. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
 - a. Minimum Glass Thickness for Exterior Lites: 1/4 inch (6 mm).
 - b. Thickness of Tinted Glass: Provide same thickness for each tint color indicated.
 7. Strength: Where annealed float glass is indicated, provide annealed float glass, heat strengthened float glass, or fully tempered float glass necessary to comply with performance requirements.
 - a. Where heat strengthened float glass is indicated, provide heat strengthened float glass or fully tempered float glass necessary to comply with performance requirements.
 - b. Where fully tempered float glass is indicated, provide fully tempered float glass.
- B. Manufacturer Qualifications for Insulating Glass Units with Sputter Coated, Low E Coatings: Insulating glass manufacturer who is approved and certified by coated glass manufacturer.
- C. Installer Qualifications, Glazer: Experience entity having minimum 5 years documented experience and who employs glass installers certified under the National Glass Association's Certified Glass Installer Program.

- D. Installer Qualifications, Decorative Film: Experience entity having minimum 5 years documented experience in the installation of glass films.
- E. Source Limitations for Glass and Glass Accessories: Obtain each type of glass and glass accessories from a single source.
- F. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- G. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- H. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
- I. Install glazing in mockups specified in Section 08 44 13 to match glazing systems required for Project, including glazing methods.
 - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- J. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass framing member for adhesion to and compatibility with elastomeric glazing sealants.
 - 1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 - 2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 - 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 - 4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
 - 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.
- K. Preinstallation Conference: Conduct conference at site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by manufacturer.
- D. Exercise exceptional care to prevent edge damage to glass, and damage/deterioration to coating on glass.
- E. Comply with insulating glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 degrees F (4.4 degrees C).
- B. Field Measurements: Verify actual dimensions of openings and construction contiguous with decorative glass by field measurements before fabrication.

1.9 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.10 WARRANTY

- A. Written warranty, executed by glass manufacturer agreeing to repair or replace glass units that fail in materials and workmanship or deteriorate within warranty period. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, and cleaning practices contrary to decorative glass manufacturer's published instructions.
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.
- B. Insulating Glass: Written warranty signed by manufacturer in which manufacturer agrees to replace insulating glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: Ten (10) years from date of Substantial Completion.
- C. Laminated Glass: Written warranty signed by manufacturer in which manufacturer agrees to replace laminated glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Glass:
 - a. AGC Glass Company North America, Inc.
 - b. Cardinal Glass Industries.
 - c. Guardian Industries Corp.; SunGuard.
 - d. Oldcastle BuildingEnvelope.
 - e. Pilkington North America.
 - f. Viracon.
- B. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- C. Ultraclear Float Glass: ASTM C 1036, Type I, Class I (clear), Quality-Q3.

- D. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.
- E. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller hearth) process with roll wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- K. Adhered Backing: Adhered scrim backing to ceramic coated surface; provide backed units identical to materials which, while possibly developing cracks and fissures, show no shear nor develop any openings large enough for the unobstructed penetration of 3 inch diameter sphere when tested by approved independent testing laboratory:
 - 1. Mount test specimens consisting of 3 glass assemblies, 34" x 76" (plus zero or minus 3/16 inch), for testing as specified in ANSI Z-97.1.
 - 2. Expose specimens to 100 cycles of the following conditions:
 - a. 1 hour at 0 degrees F, ambient humidity.
 - b. 3 hours increase from 0 degrees F to 140 degrees F, 95 to 100 percent relative humidity.
 - c. 1 hour at 140 degrees F, 95 to 100 percent relative humidity.
 - d. 3 hours decrease from 140 degrees F to 0 degrees F, ambient humidity.
 - 3. Break glass by springloaded prick punch at midpoint of either vertical edge.
 - 4. After breaking glass, subject it to pressure of 4 lbf per sq. ft. for 5 minutes to simulate wind load.
 - 5. Inorganic Opacifier: Provide polyethylene opacifier where no insulation and other backing material is applied directly to spandrel glass. Use polyester where direct attachment does occur.
 - 6. Fallout Resistance: Provide spandrel units identical to those passing fallout resistance test for spandrel glass specified in ASTM C 1048.

2.2 INSULATING GLASS

- A. Insulating Glass Units: Factory assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
- B. Performance Properties:
 - 1. Basis of Design Product: SNX 51/23 as manufactured by Guardian Sunguard.
 - 2. Outboard Substrate: Crystal Gray.
 - 3. Inboard Substrate: Clear.
 - 4. Overall Unit Thickness: 1 inch (25 mm).
 - 5. Minimum Thickness of Each Glass Lite: 1/4 inch (6 mm).
 - 6. Outdoor Lite: Fully tempered float glass.
 - 7. Interspace Content: Air.
 - 8. Indoor Lite: Fully tempered float glass.
 - 9. Winter Nighttime U-Factor: 0.29 maximum.
 - 10. Summer Daytime U-Factor: 0.20 maximum.
- C. Sealing System: Dual seal, with polyisobutylene and silicone primary and secondary sealants.
 - 1. Spacer: Aluminum with black, color anodic finish. Thermally broken aluminum.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by Technoform Glass Insulation NA, Inc.
 - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.3 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 3. Interlayer Thickness: 0.060 inch (1.52 mm).
 4. Interlayer Color: Clear unless otherwise indicated.
- B. Windborne Debris Impact Resistant Laminated Glass: Comply with requirements for laminated glass except laminate glass with ionomeric polymer interlayer to comply with interlayer manufacturer's written instructions.

2.4 GLAZING ACCESSORIES

- A. Compatibility: Provide glazing sealants compatible with one another and with other materials in contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of service and application, demonstrated by sealant manufacturer based on testing and field experience.
- B. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
- C. Colors of Exposed Glazing Sealants: Selected by Architect.
- D. Glazing Sealant: Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - d. Pecora Corporation.
 - e. Sika Corporation.
- E. Glazing Sealant: Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
 - b. Dow Corning Corporation.
 - c. GE Construction Sealants; Momentive Performance Materials Inc.
 - d. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - e. Pecora Corporation.
 - f. Polymeric Systems, Inc.
 - g. Sika Corporation.
- F. Glazing Sealant: Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bostik, Inc.
 - b. Dow Corning Corporation.
 - c. GE Construction Sealants; Momentive Performance Materials Inc.
 - d. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - e. Polymeric Systems, Inc.
 - f. Schnee-Morehead, Inc., an ITW company.
 - g. Sika Corporation.

- G. Glazing Sealant: Acid curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
 - b. Bostik, Inc.
 - c. Dow Corning Corporation.
 - d. GE Construction Sealants; Momentive Performance Materials Inc.
 - e. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - f. Pecora Corporation.
 - g. Polymeric Systems, Inc.
 - h. Schnee-Morehead, Inc., an ITW company.
 - i. Sika Corporation.
- H. Glazing Sealants for Fire rated Glazing Products: Neutral curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - 2. Colors of Exposed Glazing Sealants: Selected by Architect.
- I. Back Bedding Mastic Glazing Tapes: Preformed, butyl based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- J. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.
- K. Miscellaneous Glazing Accessories: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with proven record of compatibility with surfaces contacted in installation.
 - 1. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
 - 2. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
 - 3. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 - 4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
 - 5. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
 - 6. Perimeter Insulation for Fire Resistive Glazing: Product approved by testing agency listed and labeled fire resistant glazing product with which it is used for application and fire protection rating indicated.

2.5 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.
 - 2. Edge and Surface Conditions: Comply with the recommendations of AAMA *Structural Properties of Glass* for clean cut edges, except comply with manufacturer's recommendations.
 - 3. Exposed Glass Edges and Surface Condition: Finish edges flat with an arrissed edge profile (small bevel of uniform width not exceeding 1.5 mm at an angle of approximately 45 degrees to the surface of the glass) with polished (surface is reflective in appearance similar to the major surface of the glass) surface.
- B. Cutting: Wheel cut or sawed edges and seamed at manufacturer's option. For site cut glass, provide glass 2 inches (50.8 mm) larger than required in both dimensions to facilitate cutting of clean cut edges without the necessity of seaming or nipping. Do not cut, seam, nip or abrade heat treated glass.
- C. Butt Glazing: Clean cut or flat grind vertical edges of butt glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
Edges: Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Clean glazing channels and framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
 - 1. Comply with manufacturer instructions for wiping of surfaces immediately before application of primers.
 - 2. Wipe metal surfaces with IPA (isopropyl alcohol) unless otherwise required by compatibility and adhesion testing results.
- B. Inspect each piece of glass immediately before installation. Do not install pieces improperly sized or with damaged edges, scratches, abrasion, or evidence damage. Remove labels from glass immediately after installation.
- C. Examine glazing units to locate exterior and interior surfaces. Label or mark units so exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

- D. Seal vent (breather or capillary) tubes in insulating glass units in accordance with insulating glass manufacturer written recommendations.
- E. Glass Film Preparation:
 - 1. Remove particulate matter on the glass surface using a scraping blade.
 - 2. Place an absorbent towel on window sill or sash to absorb moisture generated by the film application.

3.3 GLAZING

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8 inch (3 mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
 - 1. Square cut wedge shaped gaskets at corners and install gaskets as recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.
- K. Tape Glazing: Position tapes on fixed stops so that, when compressed by glass, the exposed edges are flush with or protrude slightly above sightline of stops.
 - 1. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make tapes fit opening.

2. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
 3. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
 4. Do not remove release paper from tape until right before each glazing unit is installed.
 5. Apply heel bead of elastomeric sealant.
 6. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
 7. Apply cap bead of elastomeric sealant over exposed edge of tape.
- L. Gasket Glazing (Dry): Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
1. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 2. Installation with Drive in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
 3. Installation with Pressure Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
 4. Install gaskets to protrude past face of glazing stops.
- M. Sealant Glazing (Wet): Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
1. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
 2. Tool exposed surfaces of sealants to provide a substantial wash away from glass.
- N. Structurally Glazed Units: Set full height continuous structural gaskets/spacers to vertical mullions. Set glass units with void between edge of units and head/sill channel, but with units fully within head/sill rebate so as to provide a proper bite.
1. Align glass unit edges over vertical mullion continuous structural gasket/spacers and secure with manufacturers recommended temporary cleats.
 2. Structurally seal glass unit to vertical mullions with specified one part structural silicone sealant. Tool structural silicone flush in alignment to mullion face and perpendicular to face of interior glass light; remove excess structural silicone from glass and metal substrates.
 3. After full cure of structural silicone sealant remove temporary cleats. Immediately seal holes left in the vertical mullions caused by temporary cleats.
 4. Insert and shape weatherseal joint backer rods, or gaskets, into vertical void between glass units and at a proper depth to receive silicone weatherseal sealant.
 5. Place silicone weatherseal sealant into void and tool flush with adjacent exterior glass light faces; remove excess sealant from glass and metal substrates.
- O. Erection Tolerances:
1. Maximum Deviation from Vertical: 1/8 inch in any story and 1/4 inch in any 45 foot run.
 2. Maximum Deviation from Horizontal: 1/8 inch in any 30 foot run.

3. Maximum Deviation from True Alignment: 1/32 inch for any two (2) abutting units. Allow no edge projections.
4. Maximum Joint Gap: 1/32 inch.

3.4 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 1. If contaminating substances come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

PART 4 – SCHEDULE

4.1 GLAZING SCHEDULE

- A. G-1 Insulated Glass: 1 inch (25 mm) sealed insulated unit consisting of an exterior lite of 1/4 inch (6 mm) low-e tinted tempered float glass, 1/2 inch gas filled air space, and 1/4 inch (6 mm) clear tempered float glass interior lite.
- B. G-2 Hurricane Impact Resistant Glass: 1-5/16 inch sealed insulated unit consisting of an exterior lite of 1/4 inch (14 mm) low-e clear tempered float glass, 1/2 inch air space, and 9/16 inch (6 mm) low-e clear laminated glass interior lite.
- C. G-3 Clear Tempered Glass: 1/4 inch (6 mm) clear tempered float glass.

END OF SECTION 08 80 00

SECTION 08 83 00 - MIRRORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Glass mirrors with Safety Film Backing.
 - 2. Accessories necessary for a complete installation.
- B. Related Work:
 - 1. Section 08 80 00 - Glazing.

1.3 DEFINITIONS

- A. Deterioration of Mirrors: Defects developed from normal use attributable to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning mirrors contrary to mirror manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide mirrors that will not fail under normal usage. Failure includes glass breakage and deterioration attributable to defective manufacture, fabrication, and installation.

1.5 SUBMITTALS

- A. Product Data: Technical data for mirror units including description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality control provisions.
- B. Shop Drawings: Submit mirror elevations, edge details, mirror hardware, and attachments to other Work.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
 - 2. Glazing Publications: Comply with published recommendations:
 - a. *GANA Glazing Manual* unless more stringent requirements are indicated.
 - b. *GANA Mirror Division Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors.*

3. Safety Glazing Products: For tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.
- B. Installer Qualifications: Experienced installer having minimum 5 years documented experience and has completed mirror glazing similar in material, design, and extent to that indicated.
- C. Source Limitations for Mirrors: Obtain mirrors from one source for each type of mirror indicated.
- D. Source Limitations for Mirror Glazing Accessories: Obtain mirror glazing accessories from one source for each type of accessory indicated.
- E. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing and substrates on which mirrors are installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and necessary to prevent damage to mirrors from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors, protected from moisture including condensation.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.9 WARRANTY

- A. Warranty: Warranty made out to Owner and signed by mirror manufacturer agreeing to replace mirrors that deteriorate, f.o.b. the nearest shipping point to site, within specified warranty period:
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide mirrors by one of the following:
 1. Guardian Industries Corp.
 2. Trulite Glass & Aluminum Solutions; (713) 747-5430.
 3. Virginia Mirror Company, Inc.;
 4. VVP America, Inc.; Binswanger Mirror Products.
 5. Walker Glass Co., Ltd.
- B. Clear Glass Mirrors: Annealed monolithic glass, ASTM C 1503, Mirror Select Quality, clear float glass with a minimum 91 percent visible light transmission.
 1. Nominal Thickness: 6.0 mm.
- C. Setting Blocks: Elastomeric material with Type A Shore durometer hardness of 85, plus or minus 5.

- D. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- E. Mirror Mastic: Adhesive setting compound, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed. Provide product recommended by mirror manufacturer.
- F. Safety Backing: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.
 - 1. Provide at Fine Arts
- G. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
 - 1. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 inch and 7/8 inch (9.5 mm and 22 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm).
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Laurence, C. R. Co., Inc.; CRL Standard "J" Channel.
 - 2) Sommer & Maca Industries, Inc.; Aluminum Shallow Nose "J" Moulding Lower Bar.
 - 2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.04 inch (1.0 mm).
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Laurence, C. R. Co., Inc.; CRL Deep "J" Channel.
 - 2) Sommer & Maca Industries, Inc.; Aluminum Deep Nose "J" Moulding Upper Bar.
 - 3. Finish: Clear.
- H. Top and Bottom Clips: As indicated.
- I. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- J. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead shield expansion bolt devices for drilled in place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.2 FABRICATION

- A. Mirror Sizes: To suit conditions, cut mirrors to final sizes and shapes.
- B. Cutouts: Fabricate cutouts for notches and holes in mirrored glass without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrored glass.
- C. Mirror Edge Treatment:
 - 1. Cutting and Polishing: Flat edges where the clean cut square edge of the glass is flat and surface edges are slightly arissed. After grinding the arisses, polish edges to a high gloss surface where the surface reflectivity is similar in appearance to the major surface of the glass.
 - 2. Edge Sealing: Immediately after cutting to final sizes, and applying edge treatment, factory seal edges of mirrors with edge sealer to prevent chemical or atmospheric penetration of glass coating.

- D. Film Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted for compliance with installation tolerances, substrate preparation, and conditions affecting performance. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers. Proceed with mirror installation after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating surfaces with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

- A. Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images. Provide minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- B. Wall Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. For metal or plastic clips, place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges.
 - 2. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
 - 3. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips to be symmetrically placed and evenly spaced.
 - a. Fabricate bottom trim in single lengths to fit and cover bottom edges of mirrors. Locate top clips so they are symmetrically placed and evenly spaced.
 - 4. Mastic: Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
 - a. Apply mastic in vertical beads or mounds to the wall, not to the mirror back to avoid potential damage caused by mastic applicator tools, in compliance with mastic manufacturer's written instructions to allow air circulation between back of mirrors and face of mounting surface.
 - b. Make each vertical bead approximately 1/2 inch in width with minimum of one bead for every square foot of mirror.
 - c. Make each mound approximately 1-1/2 inch in diameter with a minimum of one mound for every square foot of mirror.
 - d. Do not apply mastic within 6 inches of the mirror edges to prevent squeeze out. Place beads or mounds leaving a space between mirror and wall. After mastic is applied, align mirrors and press into place. Spread each vertical bead to approximately 2 inches in width and spread each mound to a pat approximately 3-1/2 inch in diameter after pressing mirror into place.

- e. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations. Do not permit edges of mirrors to be exposed to standing water. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- B. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 08 83 00

SECTION 08 87 13 – SECURITY WINDOW FILM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Security Window Film:
 - 1. Security films of varying thicknesses, tints and reflectivity for application to existing and new glazing.
 - 2. Security Film to be applied to all exterior storefront doors and adjacent glass openings, all exterior and interior windows at entry vestibules and reception areas, and any other exterior windows that go to the floor. No security film to be applied above 10' above finished floor. Refer to drawings for additional clarification.
- B. Wet seal glazing retention system.

1.3 REFERENCES

- A. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
- B. ASHRAE - American Society for Heating, Refrigeration, and Air Conditioning Engineers; Handbook of Fundamentals.
- C. ASTM International (ASTM):
 - 1. ASTM D 882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
 - 2. ASTM D 1044 - Standard Method of Test for Resistance of Transparent Plastics to Surface Abrasion (Taber Abrader Test).
 - 3. ASTM D 4830 - Standard Test Methods for Characterizing Thermoplastic Fabrics Used in Roofing and Waterproofing.
 - 4. ASTM E 84 - Standard Method of Test for Surface Burning Characteristics of Building Materials.
 - 5. ASTM E 903 - Standard Methods of Test for Solar Absorbance, Reflectance and Transmittance of Materials Using Integrating Spheres.
- D. Consumer Products Safety Commission 16 CFR, Part 1201 - Safety Standard for Architectural Glazing Materials.
- E. NFRC 100/200 (Formerly ASTM E903) - Standard Methods of Test for Solar Absorbance, Reflectance and Transmittance of Materials Using Integrating Spheres.
- F. ISO 16933, International Standard for Glass in Building: Explosion-resistant security glazing - Test and classification for arena air-blast testing.
- G. Underwriters Laboratories Inc. (UL): UL 972 - Burglary Resisting Glazing Material.

1.4 PERFORMANCE REQUIREMENTS

- A. Meet the minimum performance requirements for each designated product type and manufacturer listed herein including:
1. Safety Glazing Impact Performance.
 2. Blast Hazard Mitigation Performance.
 3. Impact Resistance and Pressure Cycling.
 4. Adhesion to Glass.
 5. Flammability: Surface burning characteristics when tested in accordance ASTM E 84, demonstrating film applied to glass rated Class A for Interior Use
 6. Abrasion Resistance:
 7. UV Light Rejection:

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 – Submittal Procedures.
- B. Product Data: Manufacturer's current technical literature on each product to be used, including:
1. Manufacturer's Data Sheets.
 2. Preparation instructions and recommendations.
 3. Storage and handling requirements and recommendations.
 4. Installation methods.
- C. 3rd Party Test Report Submittal Requirements. Submit the following 3rd Party test reports indicating compliance with the test values listed in this section.
1. Flammability Testing, ASTM E84.
 2. Film Properties Testing, ASTM D882.
 3. Abrasion Resistance Testing, ASTM D1044.
 4. Peel Strength Testing, ASTM D3330.
 5. Puncture Strength Testing, ASTM D4830.
 6. Burglary Resistance Glazing, UL 972.
 7. Impact Resistance and Pressure Cycling, ASTMs E1886 and E1996.
 8. Blast Hazard Mitigation Testing, ASTM F1642 / F2912 and/or GSA-TS01-2003.
- D. Other Product Submittals:
1. Manufacturer's summary of 3rd Party Blast Hazard Mitigation Testing, ASTM F1642 / F2912 and/or GSA-TS01-2003.
 2. 3rd Party test reports from Forced Entry Resistance evaluations.
- E. Verification Samples: For each film specified, two samples representing actual film color and pattern.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of ten years' experience.
1. Provide documentation that the adhesive used on the specified films is a Pressure Sensitive Adhesive (PSA).
- B. Installer Qualifications: All products listed in this section are to be installed by a single installer with a minimum of five years demonstrated experience in installing products of the same type and scope as specified.
1. Provide documentation that the installer is authorized by the Manufacturer to perform Work specified in this section.

2. Provide a commercial building reference list of 5 properties where the installer has applied window film. This list will include the following information:
 - a. Name of building.
 - b. The name and telephone number of a management contact.
 - c. Type of glass.
 - d. Type of film and/or film attachment system.
 - e. Amount of film and/or film attachment system installed.
 - f. Date of completion.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 1. Finish areas designated by Architect.
 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Follow Manufacturer's instructions for storage and handling.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of hazardous materials, and materials contaminated by hazardous materials, in accordance with requirements of local authorities having jurisdiction.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed current copy of the manufacturer's standard limited warranty of not less than ten years against manufacturing defects, outlining its terms, conditions, and exclusions from coverage. Coverage shall include all materials and labor required for replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 11 Mil Window Film: Subject to compliance with requirements, provide products by one of the following:
 1. LLumar® Safety and-Security Films, an Eastman Chemical Company business: CPFilms Inc., 575 Maryville Centre Drive, St. Louis, Missouri 63141; Telephone: 800-255-8627; Email: commercialalerts@eastman.com; Web Site: www.llumar.com.
 2. Solar Gard, a subsidiary of Saint-Gobain Performance Plastics Corporation, 4540 Viewridge Ave; San Diego, CA 92123. Toll Free: (877) 273-4364. Tel: (858) 576-0200. Fax: (858) 571-3605. Email: info@solargard.com Web: www.solargard.com/us

2.2 SAFETY AND SECURITY WINDOW FILM

- A. Provide film products from a single manufacturer. Basis of Design: Magnum as manufactured by Llumar Coatings.

- B. Type 1 - Clear Films:

| Manuf. | Film Series | Product Name | Thickness | Light Trans. | Tensile Strength (psi) | Break Strength (lbs/in) |
|------------|-------------|--------------|-----------|--------------|------------------------|-------------------------|
| Llumar | Magnum | SCL SR PS11 | 11 mil | 88% | 32,000 | 324 |
| Solar Gard | Armorcoat | 11 mil | 11 mil | 88% | 30,000 | 330 |

2.3 IMPACT ATTACHMENT SYSTEMS

- A. General: Subject to compliance with testing and performance requirements, provide one of the following perimeter attachment systems.
1. Wet-glaze: The security film is applied to the glass in a fashion whereby the window glazing gaskets are trimmed and the film's edges are inserted behind the window frame. A bead of Dow Corning 995® structural silicone is then applied flush against the frame to overlap the security film and take the place of the original gasket.
 2. A minimum bead of ¾" (.75") overlapping the exposed edge of the security film, and ¾" (.75") overlapping the window frame/glazing system shall be used on all installations.
 3. Structural adhesive to be color matched whenever possible, as allowed by availability from structural sealant manufacturer. Color matched is described as matching the color of the existing glazing bead/gasket.
 4. Doors with Glass: Film applied glass edge-to-glass edge on interior of glass and Dow 995 applied under caps/stops to adhere film-to-frame-to-cap/stop.

2.3 IMPACT PROTECTION ADHESIVE:

- A. Dow Corning 995 Silicone Structural Glazing Sealant: Weatherable, UV-resistant, moisture curable structural sealant wet glaze
1. Color: Black.
 2. Material Properties (as supplied):
 - a. Typical Cure Time: 7-14 days (25 degrees C, 50% RH)
 - b. Full Adhesion: 14 - 21 days
 - c. Tack-Free Time (ASTM D 5895): 65 minutes (25 degrees C, 50% RH)
 - d. Flow, Sag or Slump (ASTM D 2202): 0.1 inches
 - e. Specific Gravity: 1.3
 - f. Working Time: 10 - 20 minutes (25 degrees C, 50% RH)
 - g. VOC Content: 30 g/L
 3. Material Properties (as cured - 21 days at 25 degrees C, 50% RH):
 - a. Ultimate Tensile Strength (ASTM D412): 350 psi (2.62 MPa)
 - b. Ultimate Elongation (ASTM D412): 525 psi
 - c. Durometer Hardness, Shore A (ASTM D2240): 40 points
 - d. Tear Strength, Die B (ASTM D624): 49 ppi
 4. Uniformity: Product shall have uniform consistency and appearance, with no clumping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Film Examination:
 - 1. Notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.
 - a. Glass surfaces receiving new film should first be examined to verify that they are free from defects and imperfections, which will affect the final appearance.
 - 2. Do not proceed with installation until glass surfaces have been properly prepared and deviations from manufacturer's recommended tolerances are corrected. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result under the project conditions.
 - 3. Commencement of installation constitutes acceptance of conditions.
- B. Impact Protection Adhesive Examination:
 - 1. Filmed glass surfaces receiving new attachment should first be examined to verify that they are free from defects and imperfections, and that the film edges extend sufficiently to the frame edges.
 - 2. Do not proceed with installation until film and frame surfaces have been properly prepared and deviations from manufacturer's recommended tolerances are corrected. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result under the project conditions.
 - 3. Perform an adhesion test to the frame surface by applying a 4 - 6 inch long bead, approximately 0.5 - 1 inch in width, masking one side of the frame surface underneath the strip with tape. Allow the Impact Protection Adhesive to cure for 7 days and test adhesion by pulling up on the masked end at a 90 degree angle. If cohesive failure is observed (adhesive residue left behind on the frame surface), adhesion is acceptable; if adhesive failure is observed (clean peel from the frame), adhesion is unacceptable and product is not recommended.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Refer to Manufacturer's installation instructions for methods of preparation for Impact Protection Adhesive or Impact Protection Profile film attachment systems.

3.3 INSTALLATION

- A. Film Installation, Location:
 - 1. Security Vestibule Exterior Front Entrance, Windows and Doors: Minimum 8 mil film applied on interior of glass
 - 2. Security Vestibule Interior (Glass between vestibule/lobby and the secured areas of the school), Windows and Doors: Minimum 15 mil film applied on secured side of glass
 - 3. Other Entrances, Windows and Doors: Minimum 8 mil film applied on interior of glass

B. Film Installation, Windows:

1. Install in accordance with manufacturer's instructions.
2. Cleanly cut and remove those portions of interior glazing gaskets which protrude beyond window's daylight opening flush with surface of frame.
3. Apply film to daylight opening of windows. Cut film edges neatly and square at a uniform distance of 1/8 inch (3 mm) to 1/16 inch of window daylight opening.
4. Spray the slip solution, composed of one capful of baby shampoo or dishwashing liquid to 1 gallon of water, on window glass and adhesive to facilitate proper positioning of film.
5. Apply film to interior of glass and lightly spray film with slip solution.
6. Squeegee from top to bottom of window. Spray slip solution to film and squeegee a second time.
7. Bump film edge with lint-free towel wrapped around edge of a 5-way tool.
8. When conditions allow, install Impact Protection Adhesive.
9. Upon completion of film application, allow 30 days for moisture from film installation to dry thoroughly, and to allow film to dry flat with no moisture dimples when viewed under normal viewing conditions.

C. Film Installation, Doors:

1. Install in accordance with manufacturer's instructions.
2. Remove interior glazing stops from door.
3. Apply film to edge of glass. Cut film edges neatly and square at a uniform distance of 1/8 inch (3 mm) to 1/16 inch of glass edge
4. Spray the slip solution, composed of one capful of baby shampoo or dishwashing liquid to 1 gallon of water, on window glass and adhesive to facilitate proper positioning of film.
5. Apply film to glass and lightly spray film with slip solution.
6. Squeegee from top to bottom of window. Spray slip solution to film and squeegee a second time.
7. Bump film edge with lint-free towel wrapped around edge of a 5-way tool.
8. When conditions allow, install Impact Protection Adhesive.
9. Upon completion of film application, allow 30 days for moisture from film installation to dry thoroughly, and to allow film to dry flat with no moisture dimples when viewed under normal viewing conditions.

D. Impact Protection Adhesive Installation:

1. Install in accordance with manufacturer's instructions.

2. Apply masking tape to film and frame surfaces to ensure a straight and consistent bead width is achieved.
3. Apply Adhesive with a minimum of 1/2 inch bead overlap on both frame and film (excluding glazing stops or compression gaskets).
4. The Impact Protection Adhesive shall be dispensed with a caulk gun with nozzle opening diameter sized to match the approximate size of the desired bead width.
5. Tool adhesive with a clean straight edge to a triangular shape maintaining consistent bead overlaps on both frame and film. Tooling inconsistencies will be cause for rejection.
6. Remove and re-install inconsistent or visually objectionable adhesive installations as determined by the Architect.
7. Remove any masking tape within working period of wet glaze prior to material skinning.
8. At doors re-install caps/stops to adhere film-to-frame-to-cap/stop.

3.4 CLEANING AND PROTECTION

- A. Remove left over material and debris from Work area. Use necessary means to protect film before, during, and after installation.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. After application of film, wash film using common window cleaning solutions, including ammonia solutions, 30 days after application. Do not use abrasive type cleaning agents and bristle brushes to avoid scratching film. Use synthetic sponges or soft cloths.

END OF SECTION 08 87 13

SECTION 08 91 00 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Fixed, extruded aluminum and formed metal louvers.
 - 2. Accessories necessary for a complete installation.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).
- D. Drainable Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind Driven Rain Resistant Louver: Louver that provides specified wind driven rain performance determined by testing according to AMCA 500-L.

1.4 SUBMITTALS

- A. Product Data: Technical data for each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
 - 3. Windstorm: Design loads as indicated on drawings.
- C. Samples: Submit for units with factory applied color finishes.

1.5 QUALITY ASSURANCE

- A. Delegated Design Submittal: For louvers indicated to comply with structural [**and seismic**] performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

- C. Windborne debris impact resistance test reports.
- D. Regulatory Requirements:
 - 1. SMACNA Standard: Comply with recommendations in *SMACNA Architectural Sheet Metal Manual* for fabrication, construction details, and installation procedures.
 - 2. Welding: Qualify procedures and personnel according to the following:
 - a. AWS D1.2/D1.2M Structural Welding Code - Aluminum.
- E. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory applied color finish.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

- A. Warrant the work specified herein for 20 years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to:
 - 1. Fading, corrosion, or other finish deterioration.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.
- D. Stainless Steel Sheet: ASTM A 240/A 240M, Type 304, No. 4 finish, with grain running parallel to length of blades and frame members..
- E. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use tamper resistant screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 3. For fastening galvanized steel, use hot dip galvanized steel or 300 series stainless steel fasteners.
 - 4. For fastening stainless steel, use 300 series stainless-steel fasteners.
 - 5. For color finished louvers, use fasteners with heads that match color of louvers.
- F. Postinstalled Fasteners for Concrete and Masonry: Torque controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FIXED, EXTRUDED ALUMINUM LOUVERS

- A. Horizontal Continuous Line, Drainable Blade Louver: 90 degree, flat face blades.
 - 1. Basis of Design: VisonGuard L20 as manufactured by RoffScreen. Other manufacturers are subject to compliance with requirements, provide products of one of the following:
 - a. Airolite Company, LLC (The).
 - b. Arrow United Industries.
 - c. Construction Specialties, Inc.
 - d. Greenheck Fan Corporation.
 - e. Ruskin Company; Tomkins PLC.
 - 2. Louver Blade: .100 inch thick, extruded aluminum, ASTM B 209, Alloy 6063-T6.
 - 3. Louver Clip: .125 inch thick, extruded aluminum, ASTM B 209, Alloy 6063-T6.
 - 4. Vertical Tree: 3 inch X 3 inch x .188 inch thick, extruded aluminum, ASTM B 209, Alloy 6063-T6.
 - 5. Self-Drilling Screw: #12-24 x 1.25 inch carbon with premium coating.
 - 6. SS Rivet: Stainless steel open end domed head .0187 inch x 0.565 inch.
 - 7. Finish: Kynar.

2.3 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field bolted assembly with close fitting joints in jambs and mullions, reinforced with splice plates.
 - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade spacing pattern unless horizontal mullions are indicated.
 - 2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
 - 1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close fitting blade splices designed to permit expansion and contraction.
 - 2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
 - 3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
 - 4. Exterior Corners: Prefabricated corner units with mitered blades with concealed close fitting splices and with fully recessed mullions at corners.

- G. Provide subsills made of same material as louvers or extended sills for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.4 FINISHES

- A. Comply with NAAMM *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.
- B. Aluminum Finishes:
 - 1. Finish louvers after assembly.
 - 2. Baked Enamel or Powder Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - a. Color and Gloss: Selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent Work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective Work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective Work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air dried coating that matches color and gloss of, and is compatible with, factory applied finish coating.

END OF SECTION 08 91 00

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Gypsum Board.
 - 2. Partition Framing Systems.
 - 3. Ceiling Suspension Systems.
 - 4. Acoustically Enhanced Gypsum Board:
 - 5. Impact Resistant Gypsum Board.
 - 6. Accessories necessary for a complete installation.

1.3 PERFORMANCE REQUIREMENTS

- A. Performance Requirements: Comply with manufacturer's load tables and the following design pressures and deflections:
 - 1. Ground Floor Lobbies: 1/120 at 15 psf.
 - 2. Partitions Receiving Monitors, Televisions, Heavy Audio/Visual Equipment: 1/360 at 15 psf.
 - 3. Typical Partitions: 1/240 at 5 psf.
 - 4. Other Partitions: 1/240 at 5 psf.
 - a. Maximum Deflection:
 - 1) L/240 at 5 lbf per sq. ft.
 - 2) L/120 at 5 lbf per sq. ft.
 - 3) L/120 at 7.5 lbf per sq. ft.
 - 4) L/120 at 10 lbf per sq. ft.
- B. STC Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.4 SUBMITTALS

- A. Product Data: Submit For each type of drywall including calculations for loadings and stresses of exterior walls and specially fabricated framing based on manufacturer's load tables.
- B. Shop Drawings: Indicate locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.
- C. Samples:
 - 1. Trim Accessories: Full size Sample in 12 inch (300 mm) long length for each trim accessory indicated.
 - 2. Textured Finishes: 12 inch by 12 inch (300 mm by 300 mm) for each textured finish indicated and on same backing indicated for Work.

- D. Calculations: Submit calculations verifying steel partition stud minimum base metal thickness and depth compliance with Code and ASTM C645 for height, load, and deflection.
- E. Evaluation Reports: ICC-ES reports for steel studs and runners.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with applicable requirements of IBC for interior finishes.
- B. Single Source Responsibility:
 - 1. Framing Members: Obtain steel framing members from single manufacturer.
 - 2. Panel Products: Obtain each type of gypsum board and other panel products from single manufacturer.
 - 3. Finishing Materials: To the extent possible, obtain finishing materials from same manufacturer supplying gypsum board products. When not possible, obtain materials from manufacturer acceptable to gypsum board manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 for gypsum board manufacturer's written instructions, whichever are more stringent.
 - 1. Do not install paper faced gypsum panels until installation areas are enclosed and conditioned.
- B. Room Temperatures: Maintain minimum 40 degrees F (4 degrees C). For adhesive attachment and finishing of gypsum board, maintain minimum 50 degrees F (10 degrees C) for 48 hours before application and continuously after until dry. Do not exceed 95 degrees F (35 degrees C) when using temporary heat sources.
- C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.
- D. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Studs and Tracks:

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) ClarkDietrich; (888) 437-3244.
 - 2) CEMCO; California Expanded Metal Products Co.; (800) 775-2362.
 - 3) MBA Building Supplies; (888) 248-8076.
 - 4) MRI Steel Framing, LLC.; (630) 616-1850.
 - 5) Phillips Manufacturing Co.; (800) 822-5055.
 - 6) Steel Network, Inc. (The); (888) 474-4876.
 - 7) Telling Industries; (866) 372-6384.
2. Ceiling Grid:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; 640-C.
 - c. CertainTeed Corporation.
 - d. USG Corporation; Drywall Suspension System.
3. Gypsum Board:
 - a. CertainTeed Corporation.
 - b. Georgia Pacific.
 - c. National Gypsum Company.
 - d. USG Corporation.
4. Base Trim:
 - a. Waterguard; www.keepsdrywalldry.com, (800) 653-8785.
 - b. Substitutions, refer to Division 1.
- B. Framing Members: ASTM C 754 for component sizes and conditions under specified maximum deflection and lateral loading conditions indicated.
 1. Steel Sheet Components: Comply with AISI S220 requirements for metal.
 2. Protective Coating: ASTM A 653/A 653M, G60 (Z180), hot dip galvanized.
- C. Steel Framing Components: ASTM C 754 for conditions indicated; hot dip galvanize complying with ASTM A 653M Z180.
 1. Steel Studs and Runners: AISI S220, 0.0179 inch (0.45 mm) minimum base metal thickness; Depth indicated on Drawings.
 2. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated. Minimum Base Metal Thickness: 0.0179 inch (0.45 mm).
 3. Cold Rolled Channel Bridging: 0.0538 inch (1.37 mm) bare steel thickness, with minimum 1/2 inch (12.7 mm) wide flanges. Depth indicated on Drawings.
 4. Clip Angle: Not less than 1-1/2 inches by 1-1/2 inches (38.1 mm by 38.1 mm), 0.068 inch (1.73 mm) thick, galvanized steel.
 5. Hat Shaped, Rigid Furring Channels: ASTM C 645; 0.0179 inch (0.45 mm) minimum base metal thickness; Depth indicated on Drawings.
 6. Resilient Furring Channels: 1/2 inch (12.7mm) deep, steel sheet members designed to reduce sound transmission. Configuration: Asymmetrical or hat shaped.
 7. Cold Rolled Furring Channels: 0.0538 inch (1.37mm) bare steel thickness, with minimum 1/2 inch (12.7mm) wide flanges.
 - a. Depth: Indicated on Drawings.
 - b. Furring Brackets: Adjustable, corrugated edge type of steel sheet with minimum bare steel thickness of 0.0312 inch (0.79 mm).
 - c. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625 inch (1.59mm) diameter wire, or double strand of 0.0475 inch (1.21mm) diameter wire.
 8. Z Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.

9. Auxiliary Framing Materials: Fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
 10. Slip Type Head Joints: Where indicated, provide one of the following:
 - a. Single Long Leg Runner System: ASTM C 645 top runner with 2 inch (50.8 mm) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging, located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
 - b. Double Runner System: ASTM C 645 top runners, inside runner with 2 inch (50.8 mm) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 - c. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs. Provide one of the following:
 - 1) ClarkDietrich; MaxTrak Slotted Deflection Track.
 - 2) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
 - 3) Superior Metal Trim; Superior Flex Track System (SFT).
- D. Ceiling Suspension Components:
1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625 inch (1.59 mm) diameter wire, or double strand of 0.0475 inch (1.21 mm) diameter wire.
 2. Hanger Attachments to Concrete:
 - a. Anchors: Postinstalled, chemical anchor or postinstalled, expansion anchor fabricated from corrosion resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - b. Powder Actuated Fasteners: Suitable for application indicated, fabricated from corrosion resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
 3. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162 inch (4.12 mm) diameter.
 4. Carrying Channels: Cold rolled, commercial steel sheet with base metal thickness of 0.0538 inch (1.37 mm) and minimum 1/2 inch (12.7 mm) wide flanges. Depth indicated on Drawings.
 5. Furring Channels (Furring Members):
 - a. Cold Rolled Channels: 0.0538 inch (1.37 mm) bare steel thickness, with minimum 1/2 inch (12.7 mm) wide flanges, 3/4 inch (19.1 mm) deep.
 - b. Steel Studs: ASTM C 645; minimum base metal thickness of 0.0312 inch (0.79 mm); Depth indicated on Drawings.
 - c. Hat Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22.2 mm) deep; Minimum base metal thickness of 0.0312 inch (0.79 mm).
 6. Resilient Furring Channels: 1/2 inch (12.7 mm) deep members designed to reduce sound transmission. Configuration: Hat shaped.
 7. Grid Suspension System for Ceilings: ASTM C 645, direct hung system composed of main beams and cross furring members that interlock.
- E. Gypsum Board: ASTM C 1396/C 1396M, applicable to type of gypsum board indicated and whichever is more stringent.
1. Core: Use Type X throughout
 - a. Thickness: 5/8 inch (15.9 mm).
 - b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

2. Ceiling Type: Manufactured for sag resistance
 - a. Thickness: 1/2 inch (13mm).
 - b. Long Edges: Tapered.
 3. Moisture and Mold Resistant Type: Type X with moisture and mold resistant core and surfaces. Core:
 - a. Thickness: 5/8 inch (15.9 mm).
 - b. Long Edges: Tapered.
- F. Impact Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
1. Core and Thickness: 5/8 inch (15.9 mm), Type X.
 2. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 3. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 4. Soft Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 5. Hard Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements according to test in Annex A1.
 6. Long Edges: Tapered.
 7. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- G. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. National Gypsum Company; (704) 365-7300.
 - b. Quiet Solution; (800) 797-8159.
 2. Core: 1-3/8 inch (35 mm), regular type.
 3. Long Edges: Tapered.
- H. Base Trim:
1. Poly Vinyl Chloride (PVC) compound meeting the requirements of ASTM C1047. ASTM D3678, ASTM D3679, and ASTM D4216.
 2. Sizes:
 - a. 1/2 inch (12.7 mm) height X 1/2 inch (12.7 mm) depth or 1/2-inch (12.7 mm) X 5/8 inch (15.875 mm).
- I. Exterior Trim: ASTM C 1047, hot dip galvanized steel sheet, plastic, or rolled zinc.
1. Shapes:
 - a. Cornerbead.
 - b. LC Bead: J shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One piece, rolled zinc with V shaped slot and removable strip covering slot opening.
- J. Interior Trim: ASTM C 1047; galvanized or aluminum coated steel sheet, rolled zinc, plastic, or paper faced galvanized steel sheet.
1. Poly Vinyl Chloride (PVC) compound meeting the requirements of ASTM C1047. ASTM D3678, ASTM D3679, and ASTM D4216.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC Bead: J shaped; exposed long flange receives joint compound.
 - d. L Bead: L shaped; exposed long flange receives joint compound.
 - e. U Bead: J shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corporation; (800) 237-9773.
 - b. Gordon, Inc.; (888) 877-8746.
 - c. Pittcon Industries; (301) 927-1000.
 - d. USG Corporation.
- K. Continuous Corner: Extruded Aluminum; continuous integral fin for surface contact with gypsum board; 7/8 inch (22 mm) wide, tapered to edge; punched with holes staggered to accept screw fastening. Prime with corrosion resistant primer. Provide Pittcon Softforms SO-HSE-90 or Schluter.
 1. Basis of Design: Pittcon Softforms SO-HSE-90; Subject to compliance with requirements, provide basis of design or comparable by one of the following:
 - a. Fry Reglet Corporation; (800) 237-9773.
 - b. Pittcon Industries; (301) 927-1000.
 - c. Schluter; (888) 472-4588.
- L. Joint Treatment: ASTM C 475/C 475M.
 1. Joint Tape:
 - a. Exterior Gypsum Soffit Board: Paper.
 - b. Joint Compound for Exterior Applications, Glass Mat Gypsum Sheathing Board: Recommended by sheathing board manufacturer.
 - c. Joint Tape, Interior Gypsum Board: Paper.
 2. Joint Compound:
 - a. Gypsum Board: Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting type taping compound.
 - 1) Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting type taping compound.
 - a) Use setting type compound for installing paper faced metal trim accessories.
 - 2) Fill Coat: For second coat, use setting type, sandable topping compound.
 - 3) Finish Coat: For third coat, use setting type, sandable topping compound.
 - 4) Skim Coat: For final coat of Level 5 finish, use setting type, sandable topping compound.
 - b. Cementitious Units: Recommended by backer unit manufacturer.
 - c. Tile Backing Panels: Recommended by backer unit manufacturer.
 - d. Water Resistant Gypsum Backing Board: Use setting type taping compound and setting-type, sandable topping compound.
 - e. Joint Compound, Glass Mat Sheathing Board: Recommended by sheathing board manufacturer.
- M. Auxiliary Gypsum Materials: Comply with referenced installation standards and manufacturer's written recommendations.
 1. Steel Drill Screws: ASTM C 1002, use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 3. Control Joints: Metal (USG #093 / Dietrich 093 Control Joint) type with 1/4 inch open joint, perforated flanges for floating in place.
 4. Acoustical Sealant: Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter

joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.; (800) 879-8000.
 - 2) Pecora Corporation; (800) 523-6688.
 - 3) Specified Technologies, Inc.; (800) 992-1180.
 - 4) United States Gypsum Company; (800) 950-3839.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow metal frames, cast in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
- B. Gypsum Board Assemblies: Comply with requirements in ASTM C 840 applicable to framing installation.
- C. Control joints shall be located 30 feet-0 inches on center maximum and along building expansion joints, unless noted otherwise on drawings. Locations shall be reviewed with Architect prior to final placement.
- D. Suspension System: Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
 1. Suspend hangers from building structure:
 - a. Install hangers plumb and free from contact with insulation or objects within ceiling plenum that are not part of supporting structural or suspension system. Splay hangers where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - 1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - c. Do not attach hangers to steel roof deck.
 - d. Do not attach hangers to permanent metal forms. Furnish cast in place hanger inserts that extend through forms.
 - e. Do not attach hangers to rolled in hanger tabs of composite steel floor deck.
 - f. Do not connect or suspend steel framing from ducts, pipes, or conduit.

2. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross furring members to each other and butt cut to fit into wall track.
- F. Framing Assembly: Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
1. Install studs so flanges within framing system point in same direction. Space studs in single layer application as indicated on drawings.
 2. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - a. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - 1) Install two studs at each jamb, unless otherwise indicated.
 - 2) Install cripple studs at head adjacent to each jamb stud, with minimum 1/2 inch (12.7mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - 3) Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - b. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 3. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.
- G. Gypsum Panels: Comply with ASTM C 840. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
1. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
 2. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
 3. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
 4. Form control and expansion joints with space between edges of adjoining gypsum panels.
 5. Cover both faces of support framing with gypsum panels in concealed spaces, except in chases braced internally.
 - a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - b. Fit gypsum panels around ducts, pipes, and conduits.
 - c. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4 inch to 3/8 inch (6.4 mm to 9.5 mm) wide joints to install sealant.

6. Isolate perimeter of gypsum board applied to nonload bearing partitions at structural abutments, except floors. Provide 1/4 inch to 1/2 inch (6.4mm to 12.7mm) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
 7. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- H. Gypsum Board: Install interior gypsum board where indicated on drawings.
1. Single Layer Application:
 - a. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 - b. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire resistance rated assembly, and minimize end joints. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - c. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
 2. Multilayer Application:
 - a. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - b. On Z shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 - c. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- I. Trim Accessories: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Attach trim according to manufacturer's written instructions.
1. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
 2. Exterior Trim: Install in the following locations:
 - a. Cornerbead: Use at outside corners.
 - b. LC Bead: Use at exposed panel edges.
 3. Interior Trim: Install in the following locations:
 - a. Cornerbead: Use at outside corners, unless otherwise indicated.
 - b. Bullnose Bead: Use at outside corners.
 - c. LC Bead: Use at exposed panel edges.
 - d. L Bead: Use where indicated or necessary.
 - e. U Bead: Use at exposed panel edges.
- J. Gypsum Board Finishing: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
1. Prefill open joints, rounded or beveled edges, and damaged surface areas.
 2. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
 3. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - a. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - b. Level 2: Panels that are substrate for tile.

- c. Level 3: Surfaces be coated with drywall primer prior to final finishes. Heavy or medium texture finishes before final painting, or where heavy-grade wall coverings are to be applied as the final decoration. This level of finish is not recommended where smooth painted surfaces, or light to medium weight wall coverings as specified. Janitorial, Electrical, Technology, & Mechanical Rooms.
 - d. Level 4: For surfaces receiving wall coverings of semigloss and eggshell paints. Hallways, Classrooms & Offices with ceilings 10' or lower
 - e. Level 5: For surfaces receiving semigloss and eggshell paint and surfaces subjected to severe lighting. Banda Hall, Libraries, Commons, Flex Spaces & Hallways with Ceilings higher than 10'.
- K. Installation Tolerances:
- 1. Suspension System: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
 - 2. Installation Tolerances, Suspension System: Install suspension systems level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
 - 3. Float Control Joints flush with wall surface so that ceiling wall mold specified separately will align with wall surface flat and straight.

3.4 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 21 16

SECTION 09 30 19 - PORCELAIN TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Thin set porcelain tile, mortar and grout, sealants, and accessories shown or required to complete work.

1.3 SUBMITTALS

- A. Product Data: Technical data including data sheets, installation recommendation, and recommended joint widths.
- B. Shop Drawings: Show locations of each type of tile and tile pattern.
 - 1. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples: Submit samples showing full range of color and texture variations expected.
 - 1. Full size units of each type and composition of tile and for each color and finish required.
 - 2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required; minimum 12 inches (300 mm) square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
 - 3. Waterproof membrane in 6 x 6-inch sample.
 - 4. Thresholds in 6 inch (150 mm) lengths.
- D. Test Reports: Submit test reports from qualified independent testing laboratory indicating and interpreting test results relative to compliance of tile products with requirements for slip resistance.
- E. Maintenance Instructions: Submit maintenance instructions for each type of product specified.
- F. Certifications:
 - 1. Provide Master Grade Certificate as specified in ANSI A137.1.
 - 2. Manufacturer's affidavits that materials used contain no asbestos.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements for the IBC for interior finishes.
 - 2. Surface Burning Characteristics: ASTM E 84; identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: 25 or less.
 - b. Smoke Developed Index: 450 or less.
 - 3. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.

- B. Source Limitations for Tile: Obtain tile of same type and color or finish from one source or producer. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- C. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- D. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
 - 1. Stone thresholds.
 - 2. Waterproofing.
 - 3. Joint sealants.
 - 4. Cementitious backer units.
 - 5. Metal edge strips.
- E. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products. Contractor shall provide certified moisture testing results per ASTM F2170 (*Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*) to Architect and Owner prior to floor installation. Acceptable moisture content of concrete sub floor shall be within approved manufacture limits or lower prior to installation.
- F. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of each type of floor tile installation.
 - 2. Build mockup of each type of wall tile installation.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided. Store liquid materials in unopened containers and protected from freezing.
- C. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.
- B. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products.

- C. Maintain temperatures at 50 degrees F or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 00 – Project Management and Coordination.

1.9 WARRANTY

- A. Warrant the Work specified herein for one (1) year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Damaged tile, including broken or chipped edges.
 - 2. Loose or missing tile.
 - 3. Noticeable deterioration or discoloring of tile or grout.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specifications are based on products of manufacturers specified. Manufacturers listed below who produce equivalent products to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions in order to be considered.
 - 1. Porcelain Tile:
 - a. American Marazzi Tile, Inc.; (972) 226-0110.
 - b. American Olean Tile Co.; (214) 398-1411.
 - c. American Tile; (713) 939-1077.
 - d. Crossville Ceramics Co.; (931) 484-2110.
 - e. Dal-Tile Corp., Dallas, TX; (713) 481-5893.
 - f. Interceramic, USA; (800) 496-8453.
 - 2. Tile Setting and Grout Materials: Those manufactured by any one (1) of the following. No substitutions.
 - a. Custom Building Products; (562) 598-8808.
 - b. Dal-Tile Corp.; (713) 481-5893.
 - c. Laticrete International, Inc., Bethany, CT; (800) 243-4788.
 - d. Mapei Americas; (800) 426-2734.

- B. Specifications are based on porcelain tile as manufactured by Dal-Tile Corp. Other manufacturers listed shall provide colors and finish equivalent to those specified.

2.2 MATERIALS

- A. PWT-2 Type: 12 inches by 24 inches by 8 MM thick porcelain tile with cushioned edge.
1. Basis of Design: Ballatore as manufactured by Marazzi.
 2. Color: To be selected by Architect from manufacturer's full color line.
 3. Finish: Unpolished and polished finish where shown on drawings or as directed by Architect.
 4. Locations: Shower walls.
 5. Base: Full porcelain wall tile to floor file.
 6. Borders and Patterns: As selected by Architect.
- B. PWT-3 Type: 2 inches by 8 inches by 8 MM thick porcelain tile with cushioned edge.
1. Basis of Design: Energy Fragments as manufactured by Emser Tile.
 2. Color: To be selected by Architect from manufacturer's full color line.
 3. Finish: Gloss finish where shown on drawings or as directed by Architect.
 4. Locations: Sink wall/Accent.
 5. Base: Full porcelain wall tile to floor file.
 6. Borders and Patterns: As selected by Architect.
- C. PWT-4 Type: porcelain tile with cushioned edge.
1. Basis of Design: Rectangular Rhombus Mosaic as manufactured by MyMosaic, Inc.
 2. Color: To be selected by Architect from manufacturer's full color line.
 3. Finish: Unpolished and polished finish where shown on drawings or as directed by Architect.
 4. Locations: Entry.
 5. Base: Full porcelain wall tile to floor file.
 6. Borders and Patterns: Custom Wave.
- D. Type D: Trim and Deco Strips porcelain tile in various sizes and finishes.
1. Color: To be selected by Architect from manufacturer's full color line
 2. Finish: Unpolished and polished finish where shown on drawings or as directed by Architect.
 3. Locations: Refer to the Drawings.
 4. Borders and Patterns: As selected by Architect.
- E. Mortar Adhesive: LATICRETE® 254 Platinum Thin-Set Mortar as manufactured by Laticrete International, Inc., Bethany, CT; (800) 243-4788, FlexBond Premium Flexible Bonding Mortar as manufactured by Custom Building Products, Seal Beach, CA; (562) 598-8808, or 1300 Universal Bonding Mortar as manufactured Dal-Tile Corp., Dallas, TX; (800)-933-8453, Ultraflex 3 as manufactured by Mapei Americas, Deerfield Beach, FL; (800)-426-2734. No substitutions.
- F. Grout: LATICRETE® Tri-Poly Fortified Grout as manufactured by Laticrete International, Inc., or Architect approved equal by any one (1) of the approved manufacturers listed above. No substitutions. Color shall be as selected by Architect from manufacturer's standard colors.
- G. Epoxy Grout (At wet areas and restroom floors & Health Care applications): Use one (1) of the following 100 percent solids epoxy grout in accordance with ANSI A118.3. No substitutions. Color shall be as selected by Architect from manufacturer's full line of available colors:
1. ARDEX L.P., WA Epoxy Grout; (724) 203-5000.
 2. Polyblend® Tile Grout with 100 percent Solids Epoxy manufactured by Custom Building Products; (562) 598-8808.
 3. LATICRETE® SpectraLOCK PRO Stainless Grout manufactured by Laticrete International, Inc.; (800) 243-4788.

4. Kerapoxy IEG, 100% Solids, Industrial-Grade Epoxy Grout manufactured by Mapei Americas; (800)-426-2734.
- H. Crack Isolation Membrane:
1. Sheet membrane used to eliminate transmission of substrate cracks from one (1) of the following approved Products/Manufacturers:
 - a. Dalseal CIS manufactured by Dal-Tile.
 - b. Crackbuster manufactured by Custom Building Products.
 - c. Mapelastic SM manufactured by Mapei.
 - d. Nobleseal CIS manufactured by The Noble Company.
 - e. Tileguard manufactured by Polyguard Products, Inc.
 2. Liquid membrane with fiberglass mesh from one (1) of the following approved Products/Manufacturers in accordance with ANSI A118.12:
 - a. Blue 92 manufactured by Laticrete International, Inc.
 - b. Fracturefree manufactured by Custom Building Products.
- I. Expansion Joint:
1. Filler: Flexible and compressible, closed-cell type, rounded at surface to contact sealant as instructed by sealant manufacturer to suit intended use.
 2. Typical Conditions except as specified below: Silicone compound sealant over filler. ASTM C920, Uses M and A, single component, mildew resistant. Sanded to match grout. Provide at all wall corners, ceilings, control joints and changes in materials, where floor tile abuts perimeter walls, curbs, columns, and pipes; and 24 feet to 36 feet elsewhere.
 3. Conditions exposed to chemicals, food processing, etc.: Polysulfide sealant over filler. ASTM C920, Grade P, Class 25, Uses T and M. Polyspec Thiokol, or Architect approved equal. Self-leveling and flexible sealant over filler of type instructed by manufacturer to suit application. Sealant shall match grout color. Expansion joints shall conform to TCA EJ171.
- J. Latex Floor Leveling Material: ARDEX K-15 Self-Leveling Underlayment Concrete manufactured by ARDEX ENGINEERED CEMENTS; (724) 203-5000 or comparable product approved by Architect.
- K. Edge Protection and Transition Strips:
1. Porcelain Tile to Gyp. Bd.: Schluter® - QUADec transition strips in aluminum finish at all porcelain tile wainscot to gyp board transition locations.
 2. Porcelain Tile to Porcelain Tile: Schluter® - QUADec transition strips in aluminum finish at all porcelain tile wall outside corner locations.
 3. Porcelain Tile to Carpet: Schluter® - SCHIENE transition strips in aluminum finish at porcelain tile to carpet transition locations.
 4. Porcelain Tile to Sealed Concrete: Schluter® - RENO-U edge protection in satin aluminum finish at porcelain tile to sealed concrete.
 5. Stair nosing: Schluter® - TREP-S GS, 10 S, aluminum support with thermoplastic rubber insert.
 6. Approved Manufacturer: Schluter® Systems LP, Plattsburg, NY; (800) 472-4588.
 7. Provide all corners and connectors as required for a complete and detailed finished installation.

2.3 EXTRA TILE

- A. Deliver four (4) unopened boxes of tile of each color tile and base from the same tile production run to the Owner at Substantial Completion.

PART 3 - EXECUTION

3.1 PREPARATION

- A. By General Contractor:
 - 1. Protect surrounding work from damage or disfiguration.
 - 2. Vacuum clean and damp clean existing substrate surfaces.
- B. By Tile Contractor:
 - 1. Examine preparatory work by others and notify Architect of any imperfections which would affect a satisfactory completion of this tile work.
 - 2. Examine substrates defects which may affect the work. Do not start work until defects have been corrected. Ensure that surfaces are:
 - a. Free of cracks, dry, clean, free of oily or waxy films, free of curing compounds.
 - b. Well cured, firm and level within TCA specified tolerances.
 - c. Minimum of 40 degrees F and rising.
- C. Absence of such notification shall constitute acceptance of responsibility by tile contractor.

3.2 INSTALLATION

- A. Crack Isolation Membrane:
 - 1. Install crack isolation membrane under tile over building control joints and substrate cracks up to 1/8 inch. Apply a 30 inch wide strip centered on control joint or crack. Install in accordance with TCA F125 and manufacturer's instructions.
 - 2. Install joint sealant in joint of first tile on both sides of control joint and crack.
 - 3. Install membrane with products or methods approved by membrane manufacturer when joining, sealing, fastening, or adhering sheet membranes.
- B. Install porcelain wall tile and porcelain pavers with aligned joints (no staggering), 1/8 inch to 3/16 inch joint width.
- C. Install porcelain pavers over crack isolation membrane in locations shown on drawings in accordance with TCA F125 and ANSI A108.5 recommendations and manufacturer's instructions.
- D. Do not use damaged porcelain tile, including those with broken or cracked edges.
- E. Lay out all work so that, where possible, no tiles less than half size occur.
- F. Install expansion joints in accordance with TCA publication EJ171. Install porcelain tile joints aligned with floor joints.
- G. Install grout in accordance with ANSI A108.10 and manufacturer's instructions.
- H. Install edge protection and transition strips in accordance with manufacturer's instructions.
- I. Damp cure grout in accordance with manufacturer's recommendations. Clean all porcelain tile surfaces upon completion. Protect finish porcelain tile work from damage.

3.3 CLEANING AND PROTECTION

- A. Clean work at completion of installation, remove excess grout from porcelain tile surfaces. Wipe all tile with a clean damp cloth, and buff lightly, leaving tile surfaces clean and ready to use.
- B. Remove grout from adjacent finish surfaces.
- C. Protect finished installation until final acceptance.
- D. Do not permit traffic over finished floor surface.

3.4 REPAIR

- A. Repair or replace damaged porcelain tile, including those with broken or cracked edges at no expense to Owner.

END OF SECTION 09 30 19

SECTION 09 51 00 - ACOUSTICAL CEILING PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Acoustical panels.
 - 2. Concealed and exposed suspension systems for ceilings.
 - 3. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Technical data for each product including installation instructions.
- B. Samples:
 - 1. Acoustic Panel: Set of 6 inch (150 mm) square samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension System Members, Moldings, and Trim: Set of 12 inch (300 mm) long samples of each type, finish, and color.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Items penetrating finished ceiling including but not limited to the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - 5. Perimeter moldings.
- D. Maintenance Data: Manufacturer data for finishes for inclusion in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements of the IBC for interior finishes.
 - 2. Acoustical Panel Standard: ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance.
 - a. Mounting Method for Measuring NRC: Plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.

3. Surface Burning Characteristics: Ceiling panels with surface burning characteristics complying with IBC Chapter 8 and ASTM E 1264 for Class A materials determined by testing identical products in accordance with ASTM E 84:
 - a. Flame Spread Index : 25 or less
 - b. Smoke Developed Index: 450 or less.
 4. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 5. Fire Resistance Ratings: Comply with ASTM E 119; testing by qualified testing agency. Identify products with appropriate markings of applicable testing agency. Indicate design designations from UL *Fire Resistance Directory* or from the listings of another qualified testing agency.
- B. Source Limitations:
1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
 2. Suspension System: Obtain each type through one source from a single manufacturer.
- C. Comply with applicable regulations regarding toxic and hazardous materials.
1. Coating Based Antimicrobial Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment; and showing no mold or mildew growth when tested in accordance with ASTM D3273.
 2. Panel Based Antimicrobial Treatment: Provide acoustical panels manufactured with antimicrobial treatment in the panels.
- D. Preinstallation Conference: Conduct conference at site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to site in original, unopened packages and store in a fully enclosed, conditioned space protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, allow panels to attain room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.7 WARRANTY

- A. Standard Ceiling Panels: Warrant ceiling panels to be free from sagging, warping, shrinking, buckling, or delaminating as a result of manufacturing defects for a period of one (1) year from the date of Substantial Completion.

- B. Sag Resistant Ceiling Panels: warrant products to be free from sagging, warping, shrinking, buckling, or delaminating as a result of manufacturing defects for a period of ten (10) years from the date of Substantial Completion.
- C. Standard Suspension System: Suspension systems shall be warranted to be free from defects in material or factory workmanship and shall not incur 50 percent red rust as defined by ASTM B117 test procedures for a period of ten (10) years from the date of Substantial Completion.
- D. Suspension system / ceiling panels: Provide manufacturers standard 15 year warranty for suspension systems when used in combination with same manufacturers sag resistant ceiling panels. Ceiling panels to be free from sagging, warping, shrinking, buckling, or delaminating as a result of manufacturing defects. Suspension systems shall not incur 50 percent red rust as defined by ASTM b117 test during the period of the warranty, extra materials.

1.8 EXTRA STOCK

- A. Furnish extra materials matching products installed and packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full size panels equal to 1 percent of quantity installed or 2 full unopened containers, whichever is greater.
 - 2. Suspension System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 - 3. Hold Down Clips: Equal to 2 percent of quantity installed.
 - 4. Impact Clips: Equal to 2 percent of quantity installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturer: Subject to compliance with requirements, provide ceiling panels and grid systems by one of the following:
 - 1. Concealed and Exposed Suspension Grid:
 - a. Armstrong World Industries, Inc.
 - b. CertainTeed Corporation.
 - c. Chicago Metallic; Rockfon (Roxul Inc.).
 - d. Hunter Douglas.
 - e. USG Interiors.
 - 2. Acoustical Ceiling Panel:
 - a. Armstrong World Industries, Inc.
 - b. CertainTeed Corporation.
 - c. Rockfon (Roxul Inc.).
 - d. Tectum Inc.
 - e. USG Interiors.
 - 3. Molding and Edge Trim:
 - a. Armstrong World Industries, Inc.
 - b. CertainTeed Corp.
 - c. Chicago Metallic Corporation.
 - d. Fry Reglet Corporation.
 - e. Gordon, Inc.
 - f. USG Interiors, Inc.; Subsidiary of USG Corporation.
 - 4. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.

5. Acoustical Sealant for Concealed Joints:
 - a. Henkel Corporation; OSI Pro-Series SC-175 Acoustical Sound Sealant.
 - b. Pecora Corporation; AIS-919.
- B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.2 METAL SUSPENSION SYSTEM

- A. Metal Suspension System: Direct hung metal suspension systems of types, structural classifications, and finishes indicated complying with applicable requirements in ASTM C 635/C 635M.
 1. High Humidity Finish: Comply with ASTM C 635/C 635M requirements for *Coating Classification for Severe Environment Performance* where high humidity finishes are indicated.
 2. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1 *Direct Hung*, unless otherwise indicated. Comply with seismic design requirements.
 - a. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - 1) Type: Cast in place, postinstalled expansion or postinstalled bonded anchors.
 - 2) Corrosion Protection: Carbon steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - 3) Corrosion Protection: Stainless steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - 4) Corrosion Protection: Components fabricated from nickel copper alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
 - b. Power Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
 3. Wire Hangers, Braces, and Ties:
 - a. Zinc Coated, Carbon Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - b. Stainless Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 - c. Nickel Copper Alloy Wire: ASTM B 164, nickel copper alloy UNS No. N04400.
 - d. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1 Direct Hung) will be less than yield stress of wire, but provide not less than 0.106 inch (2.69 mm) diameter wire.
 4. Hanger Rods and Flat Hangers: Mild steel, zinc coated or protected with rust inhibitive paint.

5. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04 inch (1 mm) thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16 inch (8 mm) diameter bolts.
 6. Hold Down Clips: Provide hold down clips spaced 24 inches (610 mm) o.c. on all cross tees in areas with exterior opening larger than 48" x 96".
 7. Impact Clips: Provide impact clip system designed to absorb impact forces against acoustical panels in Gymnasiums.
 8. Aluminum cap for use over steel grid in kitchen areas or where shown on drawings or required.
- B. Metal Suspension Systems:
1. Wide Face, Steel Capped, Double Web, Steel Suspension System: Main and cross runners roll formed from cold rolled steel sheet; prepainted, electrolytically zinc coated, or hot dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished 15/16 inch (24 mm) wide metal caps on flanges.
 - a. Structural Classification: Heavy duty system.
 - b. Face Design: Flat, flush.
 - c. Cap Finish: Color selected by Architect.
 2. Narrow Face, Steel Capped, Double Web, Steel Suspension System: Main and cross runners roll formed from cold rolled steel sheet; prepainted, electrolytically zinc coated, or hot dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished, cold rolled, 9/16 inch (15 mm) wide metal caps on flanges.
 - a. Structural Classification: Intermediate-duty system.
 - b. Face Design: Flat, flush.
 - c. Cap Finish: Color selected by Architect.

2.3 ACOUSTICAL PANELS

- A. Acoustic Panel Type ACT-1:
1. Basis of Design Product: Clean Room VL No. 868 by Armstrong World Industries.
 2. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern:
 - a. Type and Form: Type IV, mineral base with membrane faced overlay; washable vinyl film overlay.
 - b. Pattern: GH (smooth and printed).
 - c. Color: White.
 3. LR: Not less than 0.80.
 4. CAC: Not less than 40.
 5. NRC 0.10-0.15 min. in accordance with ASTM C423.
 6. Edge/Joint Detail: Square lay-in, trim edge.
 7. Thickness: 5/8 inch (15 mm).
 8. Modular Size: 24 by 24 inches (610 by 610 mm).
 9. Surface Finish: Scrubbable factory applied white vinyl plastic paint.
 10. Pattern: Non-perforated for use in commercial food service areas.
 11. Mold/Mildew inhibitor: Manufactures anti-microbial treatment in accordance with ASTM D3273.

2.4 MOLDING, TRIM AND ACCESSORIES

- A. Shadow Molding: Where an acoustical lay in ceiling abuts a gypsum board ceiling in the same plane, provide a "W" shaped reveal or "shadow" molding similar to Armstrong Shadow Molding No. 7873.

- B. Light Fixture Protection:
 - 1. Manufacturer: Thermafiber Light Protection Kit by Owens Corning or Type 5/8 or 3/4 P(S) by Armstrong World Industries.
 - 2. Fire Resistance Rating: Same as ceiling assembly rating.
 - 3. Locations: At fixtures reinstalled in fire rated ceiling assemblies.
- C. Roll Formed, Sheet Metal Edge Moldings and Trim: Type and profile for standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color used for exposed flanges of suspension system runners.
 - 1. Provide edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 - 2. For lay in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- D. Extruded Aluminum Edge Moldings and Trim: Where indicated, provide extruded aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
 - 1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
 - 2. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - 3. Baked Enamel or Powder Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- E. Acoustical Sealant: Comply with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
 - 2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut for compliance with requirements specified that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less than half width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and *CISCA Ceiling Systems Handbook*.
 - 1. Fire Rated Assembly: Install fire-rated ceiling systems according to tested fire rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers where required and, if permitted with fire resistance rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast in place hanger inserts, postinstalled mechanical or adhesive anchors, or power actuated fasteners that extend through forms into concrete.
 - 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 - 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast in place or postinstalled anchors.
- D. Panel Accessibility: Install panels downward accessible by disengaging hinge support rail on one side of panel from the T Bar Flange or optional A Mount rail flange without the use of tools, for access without removal of panel from the ceiling.

- E. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- F. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- G. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 - 1. Arrange directionally patterned acoustical panels with pattern running in one direction parallel to long axis of space.
 - 2. For square edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 - 3. For reveal edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 - 4. For reveal edged panels on suspension system members with box shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
 - 5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 - 6. Install hold-down clips in areas indicated, in areas with exterior opening larger than 48" x 96", where required by authorities having jurisdiction, and for fire resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 - 7. Install clean room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
 - 8. Protect lighting fixtures and air ducts to comply with requirements indicated for fire resistance rated assembly.

3.4 FIRE RATING SCHEDULE

- A. Refer to UL Assemblies Drawings for Fire Rating requirements of ceiling materials at rated floor and roof assemblies.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Compliance of seismic design.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
 - 1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.

- a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf (890 N) of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 00

SECTION 09 65 13 - RESILIENT BASE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Rubber base
 - 2. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Technical data for each type of product including manufacturer's installation instructions.
- B. Samples: Sample of Base Selected or Color Chart if none selected.
- C. Maintenance Data: Submit for inclusion in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Entity having minimum 5 years documented experience who employs workers competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store base and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 degrees F (10 degrees C) or more than 85 degrees F (29 degrees C). Store floor tiles on flat surfaces.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 degrees F (21 degrees C) or more than 85 degrees F (29 degrees C), in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 degrees F (13 degrees C) or more than 95 degrees F (35 degrees C).
- C. Close spaces to traffic for 48 hours after installation.

1.7 EXTRA STOCK

- A. Furnish extra materials matching products installed and packaged with protective covering for storage and identified with labels describing contents.
 - 1. Resilient Base: 1 percent of quality installed or 2 full unopened containers, whichever is greater.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design Product: Roppe. Other manufacturers are subject to compliance with requirements.
 - 1. Flexco Floors.
 - 2. Johnsite, a division of Tarkett Group.
 - 3. Mannington Commercial.
- B. Rubber Base (RB-1): ASTM F1861.
 - 1. Material: Rubber, vulcanized, Type TS, Group I, Styles A and B.
 - 2. Manufacturing Method: Group I (solid, homogeneous).
 - 3. Style: Topset cove; minimum 100 foot coil, cut to length required.
 - 4. Minimum Thickness: 0.125 inch (3.2 mm).
 - 5. Color: Selected by Architect from manufacturers full range.
 - 6. Height: 4 inches, unless indicated otherwise.
 - 7. Outside Corners: Job formed.
 - 8. Inside Corners: Job formed.
 - 9. Location: Office.
- C. Adhesives: Water resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for maximum moisture content and other conditions affecting performance of the work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified for other work and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation after correcting unsatisfactory conditions. Installation of resilient flooring and accessories indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Immediately before installation, sweep clean substrates to be covered by resilient base.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for installing flooring. Scribe and cut flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Extend flooring into toe spaces, door reveals, closets, and similar openings.

- B. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- C. Resilient Base: Comply with manufacturer's written instructions for installing resilient base. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
 - 1. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
 - 2. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
 - 3. Do not stretch resilient base during installation.
 - 4. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
 - 5. Preformed Corners: Install preformed corners before installing straight pieces.
 - 6. Job Formed Corners:
 - a. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - b. Form without producing discoloration (whitening) at bends.
 - c. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - 1) Miter or cope corners to minimize open joints.

END OF SECTION 09 65 13

SECTION 09 65 23 – LUXURY VINYL TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Luxury vinyl floor tile.
 - 2. Accessories necessary for a complete installation.

1.3 RELATED SECTIONS

- A. Section 09 65 13 – Resilient Base.

1.4 SUBMITTALS

- A. Product Data: Technical data for each type of product including manufacturer's installation instructions.
- B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples: Full size units of each color and pattern of floor tile required.
 - 1. Luxury Vinyl Tile (LVT) flooring: 18 inch by 18 inch (460 mm by 460 mm) tile in each color selected and 12 inch long piece of base material in each color selected for approval.
- D. Product Schedule: Submit for floor tile using same designations indicated on Drawings.
- E. Maintenance Data: Submit for inclusion in maintenance manuals.
- F. Reports: Certified Moisture Testing Results.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Fire Test Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - a. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
 - b. Smoke Density: Maximum specific optical density of 450 per ASTM E 662 or NFPA 258.
 - 2. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.

- B. Installer Qualifications: Entity having minimum 5 years documented experience who employs workers competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
- C. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products. Contractor shall provide certified moisture testing results per ASTM F2170 (*Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*) to Architect and Owner prior to floor installation. Acceptable moisture content of concrete sub floor shall be within approved manufacture limits or lower prior to installation.
- D. Source Limitations:
 - 1. Tile: Obtain floor products of same type and color or finish from one source or producer. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.
 - 2. Setting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 degrees F (10 degrees C) or more than 85 degrees F (29 degrees C). Store floor tiles on flat surfaces.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 degrees F (21 degrees C) or more than 85 degrees F (29 degrees C), in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 degrees F (13 degrees C) or more than 95 degrees F (35 degrees C).
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Where demountable partitions, cabinets, and similar items are indicated for installation on top of resilient tile flooring, install tile before these items are installed.
- F. Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended bond and moisture test.
- G. Install flooring after other finishing operations, including painting, have been completed.

1.8 WARRANTY

- A. Warrant the Work specified herein for ten (10) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Damaged tile, including broken or chipped edges.
 - 2. Loose or missing tile.
 - 3. Noticeable deterioration or discoloring of tile or grout.

1.9 EXTRA STOCK

- A. Furnish extra materials matching products installed and packaged with protective covering for storage and identified with labels describing contents.
 - 1. LVT Flooring: 1 percent of quality installed or 2 full unopened containers, whichever is greater.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design Product: Manufacturers and tile series, pattern, and color selections are indicated in the Finish Schedule and are a basis of design. Subject to compliance with requirements, provide product indicated in Finish Schedule or comparable product by one of the following:
 - 1. Luxury Vinyl Tile (LVT):
 - a. Basis of Design: Primary Elements by Mannington Commercial. Other manufacturers Other acceptable manufacturers include Karndean, Aspecta, Armstrong, Patcraft, Tandus Centiva, an Tarkett Company, and Mohawk, or comparable product approved by Architect.
- B. Luxury Solid Vinyl Tile (LVT-1): ASTM F 1700.
 - 1. Class: Class I, monolithic vinyl tile.
 - 2. Type: A, smooth surface and B, embossed surface.
 - 3. Thickness: 0.098 inch.
 - 4. Wear Layer Thickness: 20 mil.
 - 5. Wear Layer: Enhanced Urethane.
 - 6. Edge Treatment: Micro-bevel.
 - 7. Size: 12 inch x 12 inch.
 - 8. Construction: Heterogeneous Resilient Flooring with .030" (30 mil) high density wear layer.
 - 9. Colors: Architect to select from manufacturers full range.
 - 10. Patterns: Factory mounted patterns as selected by Architect.
- C. Trowelable Leveling and Patching Compounds: Latex modified, portland cement based formulation provided or approved by floor tile manufacturer for applications indicated. Refer to Section 03 54 00.
- D. Adhesives: Water resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- E. Floor Polish: Provide protective, liquid floor polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified for other Work and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation after correcting unsatisfactory conditions. Installation of resilient flooring and accessories indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum **95** percent relative humidity level.
 - 5. Bond Test: Bond 3' x 3' panels spaced 50 feet apart throughout subfloor area. After moisture test proves floor acceptably dry, install panels using adhesive. If panels are securely bonded after 72 hours, subfloor is sufficiently clean of foreign materials for satisfactory installation of resilient flooring.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for installing flooring. Scribe and cut flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built in furniture including

cabinets, pipes, outlets, edgings, thresholds, and nosings. Extend flooring into toe spaces, door reveals, closets, and similar openings.

- B. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- C. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one/half tile at perimeter.
 - 1. Lay tiles square with room axis.
- D. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain running in one direction.
- E. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built in furniture, cabinets, pipes, outlets, and door frames.
- F. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- H. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- I. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- J. Floor Tile: Comply with manufacturer's written instructions for installing floor tile.
 - 1. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one/half tile at perimeter.
 - a. Lay tiles square with room axis unless pattern indicated for an area.
 - 2. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles. Lay tiles with grain running in one direction.
- K. Resilient Accessories: Comply with manufacturer's written instructions for installing resilient accessories.
 - 1. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish. Apply two coat(s).
- E. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from resilient terrazzo floor tile surfaces before applying liquid cleaners, sealers, and finish products.
 - 1. Sealer: Apply two base coats of liquid sealer.
 - 2. Finish: Apply two coats of liquid floor finish.
- F. Cover floor tile until Substantial Completion.
- G. Clean floor surfaces not more than 4 days before dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean products according to manufacturer's written recommendations.
 - 1. Before cleaning, strip protective floor polish.
 - 2. Reapply polish to floor surfaces to restore protective floor finish according to flooring manufacturer's written recommendations.

END OF SECTION 09 65 23

SECTION 09 65 66 - RESILIENT ATHLETIC FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Rubber athletic rubber flooring.
- B. Adhesive and accessories required for installation, maintenance, and repair.

1.3 REFERENCES

- A. ASTM International (ASTM)
 - 1. D 2047, Standard Test Method for Static Coefficient of Friction of Polished-Coated Floor Surfaces as measured by the James Machine.
 - 2. D 2240, Standard Test Method for Rubber Property-Durometer Hardness.
 - 3. D 5116, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
 - 4. E 648, Standard Test Method for Critical Radial Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
 - 5. E 662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - 6. E 1745, Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
 - 7. F 970, Standard Test Method for Static Load Limit.
 - 8. F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
 - 9. G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - 10. F 710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- B. National Fire Protection Association (NFPA)
 - 1. 101, Code for Safety to Life from Fire in Buildings and Structures.

1.4 SYSTEM DESCRIPTION

- A. Provide a prefabricated athletic rubber flooring, dual-durometer, vulcanized and calandered with a smooth mat finish.
- B. Provide an athletic rubber sheet, which has been manufactured to maintain performance criteria stated by manufacturer without defects, damage or failure.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Include manufacturer's information for specified products, including adhesive and line paint product.
 - 2. Installation and maintenance instructions as published by the manufacturer
- B. Samples: Selection and verification samples for finishes, colors and textures.

- C. Shop Drawings: Showing layout, profiles and product components.
- D. Certification: Manufacturer's certificate of approval for adhesive and line paint product for the proposed application.

1.6 QUALITY ASSURANCE

- A. The manufacturer shall have a minimum experience of five (5) years in the manufacturing of prefabricated rubber surface.
- B. Installer shall have performed installations of the same scale in the last three (3) years.
- C. Installer shall be recognized and approved by the athletic rubber-flooring manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Materials shall be delivered in manufacturer's original, unopened and undamaged containers with identification labels intact.
- B. Store material protected from exposure to harmful weather conditions, on a clean, dry, flat surface protected from all possible damage.
- C. Recommended environmental conditions for storage is a minimum of 55 degrees F.
- D. Material shall not suffer excessive damage during handling (i.e. edge chipping, excessive warping etc).

1.8 SITE CONDITIONS

- A. Maintain a stable room and subfloor temperature for a period of 48 hours prior, during and after installation.
- B. Recommended range: 65 degrees F to 80 degrees F.
- C. Installation shall be carried-out no sooner than the specified curing time of concrete subfloor (normal density concrete curing time is approximately 28 days for development of design strength).
- D. Moisture vapor emission content of the concrete slab shall not exceed 3 lbs/1000 ft² in 24 hrs when using the Calcium Chloride test in accordance with ASTM F 1869.
- E. Installation of athletic flooring shall not commence until all other finishes in the general area have been completed.

1.9 WARRANTY

- A. Warrant the Work specified herein for ten (10) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials or workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Delamination of flooring from the substrate.
 - 2. Noticeable deterioration or discoloring of the flooring.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Specifications are based on the Sports Impact System (SF-1) manufactured by Mondo USA / Texas / Southwest, Austin, TX; (888) 966-6369. Manufacturer listed below whose product is equivalent to those specified are approved for use on the Project. Other manufacturers shall have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions to be considered.
1. Robbins, Inc., (Pulastic 2000); N.A.H., Houston, TX; (713) 956-2700.

2.2 DESCRIPTION

- A. Thickness: 0.394inch (10 mm).
- B. Color: Architect to select from manufacturers full range.
- C. Finish: Sealskin.
- D. Manufactured in two (2) layers, which are vulcanized together. The shore hardness of the top layer will be greater than that of the bottom layer; shore hardness of layers shall be as recommended by the manufacturer and the limits specified.
- E. Roll Size: Six (6) feet wide by longest practical length.
- F. Location: Treatment.
- G. Physical Properties: Prefabricated athletic rubber floor, shall conform to the following requirements:

| Performance Criterion | Test Method | Requirement | Result |
|---|-------------|-------------|---------------------------------------|
| Elongation at Break | ASTM D412 | - | >105% |
| Tensile Strength | ASTM D412 | - | >670psi |
| Static Coefficient of Friction | ASTM D2047 | ≥0.50 | >0.80 |
| Hardness (Shore A) | ASTM D2240 | - | 80 ±5 (wear layer) 77 ±5 (backing) |
| Abrasion Resistance (H18 wheel, 1000g, 1000 cycles) | ASTM D3389 | <1.0 | 0.15g |
| Critical Radiant Flux | ASTM E648 | ≥0.45 | ≥0.45 W/cm ² (Class 1) |
| Optical Density of Smoke | ASTM E662 | <450 | <450 |
| Antimicrobial Activity | ASTM E2180 | - | 99.99% reduction |
| Thickness | ASTM F386 | - | 6mm (±0.2mm) |
| Thickness of Wear Layer | ASTM F410 | - | >1.0mm |
| Resistance to Chemicals | ASTM F925 | - | Compliant |
| Static Load Limit (tested at 250psi) | ASTM F970 | - | <0.005in |
| Heat Stability | ASTM F1514 | ΔE ≤8.0 | Compliant |
| Light Stability | ASTM F1515 | ΔE ≤8.0 | Compliant |
| Indoor Air Quality | CA 01350 | - | Compliant |
| Greenguard Certification | Greenguard | - | Yes |
| Greenguard Gold | Greenguard | - | Yes |

2.3 MATERIAL

- A. Provide athletic rubber surface, in rolls as specified in Paragraph 2.2 above.

- B. Provide adhesive certified by the manufacturer, P.U. 100 Polyurethane Adhesive in accordance with the Instruction Manual of Adhesives provided by manufacturer.
- C. Patching compound and line marking paint, shall be supplied or approved/recommended by rubber athletic flooring manufacturer.
- D. Other Materials: Provide other materials, not specifically described, but required for a complete and proper installation.

2.4 EXTRA MAINTENANCE AND REPAIR STOCK

- A. Deliver to the Owner for his use:
 - 1. One (1) roll of each color used in Project.
 - 2. One (1) gallon container of each type adhesive used for flooring.
- B. Provide additional amount of approximately two (2) percent of the total floor surface, of each type and color.
- C. Repair material shall be from the same dye lot as material supplied for initial installation.
- D. Maintain surface in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSTALLERS

- A. Installer shall have performed installations of the same scale in the last three (3) years.
- B. Installer shall be recognized and approved by the athletic rubber-flooring manufacturer.

3.2 EXAMINATION AND PREPARATION

- A. The following shall be ensured prior to installation of the primary product:
 - 1. Concrete substrate is placed a minimum of 30 days prior to the installation of athletic rubber floor.
 - 2. No concrete sealers or curing compounds are applied or mixed with the subfloor.
 - 3. Concrete subfloors on- or below-grade or installed over a suitable moisture barrier membrane complying with ASTM E 1745 Class A.
 - 4. Alkalinity test and moisture test is preformed. PH level shall be in the range of 7 to 8.5. Moisture content does not exceed 3 lbs/1000 ft² in 24 hrs (verify using the calcium chloride test in accordance with ASTM F 1869).
 - 5. Smooth, dense finish, highly compacted with a tolerance of 1/8 inch in a ten (10) feet radius. Floor Flatness and Floor Levelness (FF and FL) numbers are not recognized.
 - 6. Subfloors are clean, free of paint, dust, sealer, hardeners, grease, oil, solvents and other foreign substances that may act as a bond barrier.
 - 7. Sealing of cracks, holes and, smoothing and leveling of rough, uneven surfaces, are performed using a good quality Portland cement based leveling compound (feathering compound), approved by the manufacturer.
 - 8. The beginning of installation stipulates the acceptance of surface and site conditions.
 - 9. Installation is not performed unless conditions stated above are satisfied.
 - 10. All discrepancies are reported to the General Contractor for correction.

3.3 INSTALLATION

- A. Install athletic flooring in accordance with manufacturer's Installation Instructions.

- B. Unroll sheet and allow relaxation.
- C. Inspect sheet for damages or defects.
- D. Always install the flooring in the same direction.
- E. Cut and adjust flooring prior to installation.
- F. All edges shall be straight-edged before adjusting the seams.
- G. Mix adhesive in accordance with manufacturer's instructions.
- H. Roll flooring in both directions with a 100 pound sectional floor roller.
- I. Check for air bubbles and continue rolling if needed.
- J. Roll the seam with a hand roller and remove excess adhesive that may have come through the seam.
- K. Hold all seams in place with suitable weights for a minimum of 12 hours.
- L. Repeat the same procedure for the rest of the installation.
- M. Lines shall be painted in accordance with manufacturer's instructions.
- N. Surface shall be protected before, during and after installation until project's acceptance by the Owner, or his agent.
- O. Allow adhesive to set 72 hours before initial cleaning of the surface.
- P. As needed, protect flooring with 1/8" Masonite during and after the installation, prior to acceptance by the Owner.

END OF SECTION 09 65 66

SECTION 09 67 00 - EPOXY FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Epoxy floor system one with a 3/16th inch nominal thickness and 1/8th inch troweled Epoxy Mortar Base.
 - 2. Accessories necessary for a complete installation.

1.3 DEFINITIONS

- A. Comparable Product: Product demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.4 SUBMITTALS

- A. Product Data: Technical data for each type of product indicated include manufacturer's technical data, application instructions, and recommendations for each flooring component required.
- B. Samples: Submit flooring system required, 6 inches (150 mm) square, applied to a rigid backing.
 - 1. Two samples indicating range of slip resistant textures
 - 2. Two samples of actual color and texture selected by the Architect.
- C. Reports and Certificates:
 - 1. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- D. Maintenance Data: Submit data for flooring system to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Comply with applicable requirements of the IBC for interior floors.
 - 2. Fire Test Response Characteristics: Determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 3. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
 - 4. Flammability: Self-extinguishing according to ASTM D 635.
- B. Installer Qualifications: Installer having minimum 5 years documented experience in the installation of epoxy floors and who is a manufacturer authorized representative trained and

approved for installation of flooring systems required. Engage installer certified in writing by floor manufacturer as qualified to apply flooring systems indicated.

- C. Source Limitations: Obtain primary flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
- D. Contractor is required to achieve the specified concrete moisture content prior to installation of all flooring materials or use a flooring manufacture approved moisture barrier prior to installation of all flooring products. Contractor shall provide certified moisture testing results per ASTM F2170 (*Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes*) to Architect and Owner prior to floor installation. Acceptable moisture content of concrete sub floor shall be within approved manufacture limits or lower prior to installation.
- E. Preinstallation Conference: Conduct conference at site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and conditions affecting resinous flooring application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- C. Close spaces to traffic during flooring application and for 24 hours after application unless manufacturer recommends a longer period.

1.8 WARRANTY

- A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (1) full year from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) full year from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design (EPX-1): Stonshield HRI as manufactured by Stonhard; subject to compliance with requirements, provide products by one of the following:
 - 1. BASF Corporation; Construction Systems.
 - 2. Crossfield Products Corp.
 - 3. Sherwin-Williams Company, General Polymers.
 - 4. Sika Corporation; Flooring.

- B. Flooring System: 1/8th inch troweled epoxy mortar base with added decorative quartz broadcast simple broadcasts and or slurries will not be accepted. Overall system depth is 3/16th inch.
- C. Primer Formulation Description Basis of Design: Stonhard Standard Epoxy Primer two component 100% solid squeegee applied and back rolled.
- D. Formulation Description: Body Coat HRI Base:
 - 1. Resin: Stonshield HRI Base is 100% solid 4 part Epoxy Mortar Base troweled at 1/8th inch.
 - 2. Formulation Description: HRI base is comprised of a four part epoxy mortar, consisting of pigmented epoxy resin, curing agent, and pigmented blended aggregates.
 - 3. Application Method: Troweled Mortar. No slurries or simple broadcasts will be accepted.
 - a. Mortar: Mechanical preparation of substrate and then apply Standard Primer. Uniformly Trowel 1/8th inch mortar over substrate. Apply three component Stonshield undercoat then broadcast decorative quartz into undercoat until refusal and seal with CE4 Epoxy sealer.
- E. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
 - 1. Static load Limit: 0.004in/0.1mm.
 - 2. Resistance to Heat: Delta E>8 per ASTM F-970.
 - 3. Hardness: 85 Min. per ASTM D-2240/Shore D Durometer.
 - 4. Residual Indentation: 1% thickness per ASTM F- 1914.
 - 5. Noise Reduction Coefficient: 0.05 per ASTM C-423.
 - 6. Abrasion Resistance: 0.01gm per ASTM D-3389, H-18 500g, 1000 cycles.
 - 7. Fire Resistance: Class 1, Per ASTM E-648.
 - 8. Slip Resistance Index: >0.06 dry, >.05 wet, per ASTM F-1679.
 - 9. Compressive Strength 10,000 PSI ASTM C-579
 - 10. Tensile Strength 2,000 PSI ASTM C-307
- F. System Characteristics:
 - 1. Color and Pattern: Architect to select from manufacturers full range.
 - 2. Wearing Surface: Medium.
 - 3. Integral Cove Base: 4-6 inches high with zinc termination strip.
 - 4. Overall System Thickness: 3/16 inch (4.7625 mm). Must include 1/8th inch troweled epoxy mortar base.
- G. Antimicrobial Additive: Antimicrobial chemical additive to control growth of most bacteria, fungi, algae and actinomycetes.
- H. Primer/Waterproofing Membrane: Type recommended by flooring manufacturer for substrate and flooring system indicated. Use only where indicated on drawings and finish schedule.
- I. Patching and Fill Material: Resinous product approved by flooring manufacturer and recommended by manufacturer for application indicated. Use where indicated on pitch and leveling schedule.
- J. HRI mortar base: Troweled 1/8th inch 4 component epoxy mortar.
- K. Undercoat:
 - 1. Resin: Stonshield Undercoat.
 - 2. Formulation Description: Epoxy
 - 3. Type: Clear.
 - 4. Finish: Gloss.
 - 5. Number of Coats: one.
 - 6. Broadcast quartz into undercoat

- L. Topcoats:
 - 1. Resin: epoxy.
 - 2. Type: Two-component 100% solids
 - 3. Type: Clear.
 - 4. Finish: Gloss.
 - 5. Number of Coats: one

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - 1. Remove existing floor covering, adhesives, and contaminates. Ensure existing concrete floor is ready to receive epoxy floor covering.
 - 2. Roughen concrete by Shot Blasting (mechanical preparation only) substrates complying with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
 - 3. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
 - 4. Verify that concrete substrates are dry and moisture vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) of slab area in 24 hours.
 - b. Plastic Sheet Test: ASTM D 4263. Proceed with application after testing indicates absence of moisture in substrates.
 - c. Relative Humidity Test: Use in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - 5. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
 - 1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.
- D. Epoxy Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 APPLICATION

- A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - 2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
- B. Primer/Waterproofing Membrane: Apply primer or waterproofing membrane over entire substrate surface in manufacturer's recommended thickness. Where indicated.
 1. Apply to integral cove base substrates.
- C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Do not broadcast into cove. Mix quartz aggregates and add thixotropic and hand trowel. Round internal and external corners.
 1. Integral Cove Base: 4-6 inches (TBD as scheduled)
- D. Trowel HRI Base to 1/8th inch then apply Stonshield undercoat.
- E. Quartz Granules: Broadcast Quartz into Undercoat. Scrape off and vacuum up excess aggregate.
- F. Topcoats: Trowel or squeegee apply clear epoxy resin coat topcoats indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.3 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 00

SECTION 09 90 00 - PAINTINGS AND COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Surface preparation and field painting of exposed items and surfaces.
 - 2. Field preparation and painting of factory primed metal products and fabrications.
 - 3. Accessories necessary for a complete installation.

1.3 DEFINITIONS

- A. Standard coating terms defined in ASTM D 16 apply.
 - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85 degree meter.
 - 2. Eggshell refers to low sheen finish with a gloss range between 20 and 35 when measured at a 60 degree meter.
 - 3. Semigloss refers to medium sheen finish with a gloss range between 35 and 70 when measured at a 60 degree meter.
 - 4. Full gloss refers to high sheen finish with a gloss range more than 70 when measured at a 60 degree meter.

1.4 SUBMITTALS

- A. Product Data: Submit technical data and information for block fillers, primers, paints, and coatings, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
 - 1. Indicate manufacturer's instructions for special surface preparation procedures, substrate conditions requiring special attention.
 - 2. Material List: Provide inclusive list of required coating materials. Indicate each material and cross reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number, series, and general classification.
- B. Samples: Submit for each type of paint system and in each color and gloss of topcoat.
 - 1. Provide stepped samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
 - 2. Provide list of material and application for each coat of each sample. Label each sample as to location and application.
 - 3. Submit samples on following substrates for review of color and texture only:
 - a. Concrete: Provide two 4 inch square samples for each color and finish.
 - b. Concrete Masonry: Provide two 4" x 8" samples of masonry, with mortar joint in the center, for each finish and color.
 - c. Painted Wood: Provide two 12 inch square samples of each color and material on hardboard.
 - d. Ferrous and Nonferrous Metals: Provide two 4 inch square samples of flat metal and two 8 inch long samples of solid metal for each color and finish.

- C. Product List: Submit list of including each paint system, color, and location of application. Use same product and location designations indicated in Finish Schedule.
- D. Coating Maintenance Manual: Upon conclusion of the project, the Contractor or paint manufacturer/supplier shall furnish a coating maintenance manual, such as Sherwin-Williams "Custodian Project Color and Product Information" report or equal. Manual shall include an Area Summary with Finish Schedule, Area Detail designating where each product/color/finish was used, product/color/finish was used, product data pages, Manual Safety Data sheets, care and cleaning instructions, touchup procedures, and color samples of each color and finish used.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with Federal and local toxicity and air quality regulations and with Federal requirements on content of for heavy metals including but not limited to: lead and mercury. Do not use solvents in paint products that contribute to air pollution.
 - 2. Performance and Durability:
 - a. ASTM D 16 – "Standard Test Method for Load Testing Refractory Shapes at High Temperatures."
 - b. ASTM D 2486 – "Standard Test Method for Scrub Resistance of Interior Wall Paint."
 - c. ASTM D 2805 – "Standard Test Method for Hiding Power of Paints by Reflectometry."
 - d. ASTM D 4828 – "Standard Test Method for Practical Washability of Organic Coatings."
 - e. ASTM D 3363 – "Standard Test Method for Film Hardness by Pencil Test."
- B. Applicator Qualifications: A firm or individual having minimum 5 years documented experience in applying paints and coatings similar in material, design, and extent to those indicated.
- C. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well ventilated areas with ambient temperatures continuously maintained at not less than 45 degrees F (7 degrees C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply waterborne paints when temperatures of surfaces to be painted and surrounding air are between 50 degrees F and 90 degrees F (10 degrees and 32 degrees C).
- B. Do not thin or add water to waterbased paints, including waterbased alkyds.
- C. Weather Conditions:
 - 1. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
 - 2. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 degrees F (3 degrees C) above dew point; or to damp or wet surfaces.
 - 3. Minimum Application Temperatures for Water based Paints: Between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C).

- D. Apply solvent thinned paints when temperatures of surfaces to be painted and surrounding air are between 45 degrees F. and 95 degrees F (7 degrees F and 35 degrees C).
 - 1. Minimum Application Temperature for Varnish Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.
 - 2. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.
- E. Provide lighting level of 80 foot candles (860lx) measured midheight at substrate surface.
- F. Labels: Do not paint over Underwriters Laboratories, Factory Mutual, other code required labels, or equipment name, identification, performance rating, or nomenclature plates.

1.8 WARRANTY

- A. Written warranty signed by the manufacturer and the installer in which the manufacturer and installer agree to repair or replace paint and primers that fail within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Flaking or delamination of paint with the substrate.
 - b. Rust, scale, similar imperfections due to improper surface preparation.
 - c. Thinning or watering of paint beyond that considered acceptable of paint manufacturer.
 - d. Failure to achieve dry film thickness (DFT) recommended by manufacturer for each coat in a paint system.
 - e. Deterioration or loss of color of paint beyond normal weathering.
 - 2. Warranty Period: Two (2) years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 2 percent, but not less than 1 gallon (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Specifications: Sherwin Williams paints. Subject to compliance with requirements, provide first quality, 100% acrylic, commercial or industrial products of one of the specified manufacturers. Residential products are not permitted.
 - 1. Proprietary Names: Paint Schedule is based on a single manufacturer for convenience. Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that named products are required to the exclusion of comparable products of specified manufacturers. Furnish product technical data, including per cent solids by weight and volume; VOC content limits and emissions data; and certificates of performance for comparable paint products of specified manufacturer.
 - 2. Paint Products:
 - a. PPG Industries, Inc.
 - b. Sherwin-Williams Co.
- B. Material Compatibility: Provide each paint system including block fillers, primers, and finish coats, that are compatible with one another and with substrates indicated under conditions of service and application, demonstrated by manufacturer based on testing and field experience.

- C. **Material Quality:** Provide manufacturer's best quality commercial paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint material containers not displaying manufacturer's product identification will not be acceptable. Residential quality paint products are not permitted.
- D. **Chemical Components of Interior Paints and Coatings:** Provide products complying with limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. **Aromatic Compounds:** Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 - 2. **Restricted Components:** Paints and coatings shall not contain components restricted by the EPA.
- E. **Accessories:** Materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- F. **Patching Materials:** Latex filler compatible with paint systems.
- G. **Fastener Head Cover Materials:** Latex filler.

2.2 SOURCE QUALITY CONTROL

- A. **Testing of Paint Materials:** Owner reserves the right to invoke to engage the services of a qualified testing agency to sample paint materials.
 - 1. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to site, samples may be taken at the site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Examine substrates and conditions for compliance with requirements for maximum moisture content and conditions affecting performance of the work.**
- B. **Test substrates after repairing and cleaning substrates but prior to application of paint and coatings.**
 - 1. **Maximum Moisture Content of Substrates:** When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Fiber Cement Board: 12 percent.
 - c. Masonry (Clay and CMUs): 12 percent.
 - d. Wood: 15 percent.
 - e. Gypsum Board: 12 percent.
 - f. Plaster: 12 percent.
 - 2. **Test cementitious and plaster cement/stucco for alkalinity (pH).**

- C. Gypsum Board Substrates: Verify joints are taped and finishing compound is sanded smooth.
- D. Plaster Substrates: Verify plaster has fully cured. Verify existing plaster is in good condition and can receive new paint coating.
- E. Spray Textured Ceiling Substrates: Verify surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
 - 1. Verify previously painted surfaces can be stripped to bare substrate, repaired if necessary, and prepared to receive new paint system consisting of primer and two top coats at a minimum.
 - a. Note: If previously painted surfaces have failed to accept new paint systems, determine cause of failure and take corrective measures to ensure each surface accepts new paint system. Failure of new paint system is not permitted.
- G. Commence paint and coating application after correcting unsatisfactory conditions and surfaces are dry. Application of coating indicates applicator's acceptance of surfaces and conditions.

3.2 ITEMS TO RECEIVE PAINT

- A. Generally, all new items that are normally painted in any typical building, including but not limited to the following list:
 - 1. All ferrous metal.
 - 2. All exterior galvanized metal.
 - 3. All interior wood.
 - 4. All prime coated hardware.
 - 5. All exposed pipe, plumbing, ductwork, conduit, outlet boxes and electrical cabinets, excluding those located in mechanical rooms.
 - 6. Aluminum and copper items, unless noted otherwise. (Painting of exposed pipe, including copper, brass, galvanized and black iron pipe and fittings, is included.)
 - 7. All metal grilles, except aluminum, unless otherwise indicated.
 - 8. All exposed gypsum board surfaces, including all mechanical rooms.
 - 9. Sealants of types which should not be painted and to which paint will not adhere.
 - 10. Aluminum, stainless steel, nickel and chrome plated piping and fittings.
 - 11. Miscellaneous other items which normally require painting or are scheduled to be painted.
 - 12. Consult plans, finish schedule, details and specifications for other trades as all items usually field painted or finish will be considered as part of the Contract.
 - 13. All exposed mechanical equipment and electrical equipment.
 - 14. Traffic lanes and parking spaces including fire lanes and crosswalks.
 - 15. Loose lintels.
 - 16. Refer to MEP specifications for additional items to receive paint.
- B. All work where a coat of material has been applied must be inspected and approved by Architect before application of succeeding specified coat, otherwise no credit for coat applied will be given. Notify Architect when a particular coat has been completed for inspection and approval. Apply coats of material in strict accordance with manufacturer's specifications except where requirements of these specifications are in excess of manufacturer's requirements. Paint all sight exposed pipe and plumbing only after all mechanical work and tests have been completed.

3.3 PREPARATION

- A. Coordination of Work: Review work in which primers are provided to ensure compatibility of the total system for various substrates. Notify Architect of anticipated problems when using materials specified over substrates primed by others.

1. Preprimed Substrates: Inspect existing conditions in which primers are factory applied to ensure compatibility of the total system for each substrate. Notify Architect of anticipated problems when using the materials specified over factory primed or preprimed substrates.
 2. Existing Painted Surfaces: Inspect previously painted surfaces to ensure compatibility of the existing paints with new paint system for each substrate. Notify Architect of anticipated problems.
 3. Correct defects and clean surfaces affecting bond with paint system. Remove existing paints exhibiting loose surface defects showing signs of rust, scale, or delamination.
 4. Seal marks which may bleed through surface finishes.
- B. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified. Provide barrier coats over incompatible primers or remove and reprime. If removal is impractical or impossible because of size or weight of item, provide surface applied protection before surface preparation and painting
1. Remove hardware and hardware accessories, plates, lighting fixtures, and similar items that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface applied protection before surface preparation and painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
 2. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface applied protection if any.
 3. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 4. Clean and prepare surfaces to receive paint according to manufacturer's written instructions for each substrate condition and as specified. Provide barrier coats over incompatible primers, existing paint or coating, or remove and reprime.
 5. Correct defects and clean surfaces affecting bond with paint or coating system. Remove existing coatings exhibiting loose surface defects. Seal marks which may bleed through surface finishes.
- C. Cleaning: Before applying paint or surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning. Schedule cleaning and painting so dust and contaminants from the cleaning process will not fall on wet, newly painted surfaces.
1. Remove incompatible primers, including factory applied primers, and reprime substrate with compatible primers or apply barrier coat as necessary to produce paint systems indicated.
 2. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
 3. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.
 4. Galvanized Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
 5. Aluminum Substrates: Remove surface oxidation.
- D. Mildew and Mold Removal: Remove mildew and mold by high power washing (pressure range of 1500 to 4000 psi) with solution of trisodium phosphate and bleach. If substrate is too soft for high power washing, scrub substrate with solution. Rinse with clean water and allow surface to dry.
- E. Protective Coverings: Provide protections for duration of the work, including covering furnishings and decorative items. Protect and mask adjacent finishes and components against

damage, marking, overpainting, and injury. Clean and repair or replace damage caused by painting.

- F. Renovated Surfaces: Clean surface free of loose dirt and dust. Except at gypsum board surfaces, remove existing paint and coatings to bare substrate and prepare substrates to receive new paint system. Test substrate to verify it will bond with primer and receive new paint system without failure. If test fails, clean surface to base substrate and apply barrier coat. Retest to verify surface will accept new paint system.
1. Remove surface film preventing proper adhesion and bond.
 2. Wash glossy paint with a solution of sal soda and rinse thoroughly.
 3. Remove loose, blistered, and defective paint and varnish; smooth edges with sandpaper.
 4. Clean corroded iron and steel surfaces.
 5. Repair and blend into portland cement plaster.
 6. Prime bare surfaces.
 7. Tone varnished surfaces with stain bringing to uniform color.
 8. If existing surfaces cannot be put in acceptable condition for finishing by customary cleaning, sanding, and puttying operations, notify Owner and do not proceed until correcting unsatisfactory conditions.
- G. Cementitious Substrates: Prepare concrete surfaces to receive paint. Remove efflorescence, chalk, dust, dirt, grease, oils, release agents, mold, mildew, and existing paint. Roughen as necessary to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
1. Use abrasive blast cleaning methods if recommended by paint manufacturer.
 2. Do not paint surfaces if moisture content or alkalinity of surfaces exceeds that permitted in manufacturer's written instructions.
 - a. Determine alkalinity and moisture content of surfaces by performing appropriate pH testing. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct condition prior to application of paint.
 - b. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m).
 - c. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation after substrates have obtained percent relative humidity level recommended by paint manufacturer.
 - d. Perform additional moisture tests when recommended by manufacturer. Proceed with installation when moisture content complies with that permitted in manufacturer's written instructions.
 - e. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water. Allow to thoroughly dry.
 3. Clean concrete floors to receive paint or coating with a 5 percent solution of muriatic acid or etching cleaner. Flush floors with clean water to remove acid; neutralize with ammonia, rinse, allow to dry; vacuum before painting.
- H. Ferrous Metals: Clean ungalvanized ferrous metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC recommendations.
1. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
 2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

- I. Galvanized Ferrous Metal Substrates: Clean galvanized surfaces with nonpetroleum based solvents leaving surface free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- J. Shop Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop primed surfaces.
- K. Aluminum Substrates: Clean surfaces to remove oil, grease, surface oxidation, and contaminants in accordance with SSPC SP-1 Solvent Cleaning. Lightly abrade surface with a nonmetallic pad.
- L. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- M. Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
- N. Wood Substrates:
 - 1. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime, stain, or seal wood to be painted. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.
 - 4. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
 - 5. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- O. Pipe Covering and Insulation: Clean to remove loose, foreign, and objectionable material before applying sealing coat.
- P. Barrier Coat: Provide barrier coats over incompatible primers or remove and reprime. Notify Owner in writing of anticipated problems using specified finish coat material over previously coated substrates.
- Q. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Do not use thinners for water based paints.
 - 4. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.4 APPLICATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
1. The term *exposed surfaces* includes areas visible when permanent or built in fixtures, grilles, convector covers, covers for finned tube radiation, and similar components are in place. Extend coatings in these areas to maintain system integrity and provide desired protection.
 2. Use applicators and techniques suited for paint and substrate indicated.
 3. Provide finish coats compatible with primers.
 4. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 5. Paint exposed surfaces. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces.
 - a. Field painting of exposed surfaces include bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory applied final finish.
 - b. Areas visible when permanent or built in fixtures, grilles, convector covers, covers for finned tube radiation, and similar components are in place.
 - c. Extend coatings in areas, as required, to maintain system integrity and provide desired protection.
 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 7. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 8. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 9. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 10. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or surface imperfections. Cut in sharp lines and color breaks.
 11. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 12. Provide finish coats compatible with primers used.
 13. Sand lightly between each succeeding enamel or varnish coat.
- B. Items not to Receive Paint: Do not paint prefabricated items, concealed surfaces, operating parts, and labels.
- C. Applicators: Apply paints and coatings by brush, roller, spray, or applicators recommended by manufacturer.
1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size recommended by manufacturer for material and texture required.

- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
1. Measure film thickness on magnetic surfaces by use of Elcometer thickness gauge and on nonmagnetic surfaces by pit gauge or Tooke Gauge.
- E. Application: Apply first coat to surfaces that have been cleaned, pretreated, or prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
 2. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished after removing rust and scale and priming or touching up surface sand if acceptable to topcoat manufacturers.
 3. If undercoats, stains, or conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried and cured to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- F. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.
1. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
 2. Prime and paint uninsulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, heat exchangers, tanks, ductwork, conduit, switchgear, and paintable insulation except where items are prefinished.
 3. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
 4. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
 5. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated. Color band and identify with flow arrows, names, and numbering.
 6. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
 7. Concealed Members: Wherever steel and metal parts to receive paint are built into and concealed by construction, paint as specified for exposed parts so finish painting is complete before members are concealed.
- G. Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work: Painting is limited to items exposed in equipment rooms and occupied spaces.
1. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
 2. Prime and paint uninsulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, heat exchangers, tanks, ductwork, conduit, switchgear, and paintable insulation except where items are prefinished.
 3. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

4. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
 5. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated. Color band and identify with flow arrows, names, and numbering.
 6. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- H. Block Fillers: Apply block fillers to concrete masonry block at rate to ensure complete coverage with pores filled.
- I. Prime Coats: Before applying finish coats, apply prime coat, recommended by manufacturer, to material required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or defects due to insufficient sealing.
- J. Finish Coats: Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance without bleed through.
1. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or surface imperfections is not acceptable.
 2. Transparent (Clear) Finishes: Use multiple coats to produce glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats.
- K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- L. Touch Up: Touch up marred, scraped, and blemished areas of surfaces which were factory primed or previously coated.
1. Prepare and touch up scratches, abrasions, and blemishes and remove foreign matter before proceeding with succeeding coats.
 2. Touch up marred, scraped, and blemished areas of factory primed or previously coated surfaces.
 3. Feather touch up coating overlapping minimum 2 inches onto adjacent unblemished areas producing smooth, uniform surface.
 4. As soon after erection and installation as possible, touch up fasteners, welded surfaces and surroundings, field connections, and areas on which shop coat has been abraded or damaged with specified primer before corrosion and other damage occurs from exposure.

3.5 FIELD QUALITY CONTROL

- A. Dry Film Thickness (DFT) Testing: Tests for dry film thickness may be determined by using a Tooke Scale and microgroover, an electronic scanner, or the Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.6 CLEANING AND PROTECTION

- A. It is of the upmost importance to the client that the site remains in a safe, clean, and well maintained condition. At the end of each day, leave the site ready to use by staff and students. Protect staff and students and the learning environment throughout the work.
- B. Cleanup: At the end of each day, remove empty cans, rags, rubbish, and discarded paint materials from site. After completion of painting work, clean glass and paint spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. Provide *Wet Paint* signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work. After related work is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.
- E. At completion of painting activities, touch up and restore damaged or defaced painted surfaces.
- F. Waste Management: Legally dispose of unused paint and paint containers in accordance with manufacturer's recommendations and environmental regulations.

PART 4 - SCHEDULES

- A. The following is a schedule of typical painted items and does not specifically include every item that is to receive paint but should establish type and quality of finish for all items normally included in a complete paint job.
- B. Exterior Surfaces: Note: Exterior surfaces are divided into two (2) different categories, based upon color and level of graffiti resistance required. System 1 will be used when standard earthtone colors or neutral colors are specified, and System 2 will be used when bright colors (primary reds, yellows, and oranges) are specified and/or when a graffiti resistant coating is required.
 - 1. Galvanized Metal: Chloramine environment.
 - a. Surface Preparation: Acid etch galvanized surfaces that have not weathered at least six (6) months prior to beginning painting operations.
 - b. Finish: Two (2) coats Macropoxy 646 (B58-600).
 - 2. Fiber-Cement Materials:
 - a. Primer: One (1) coat Loxon Masonry Primer (A24W300)
 - b. Finish: Two (2) coats A-100 Acrylic Gloss (A8 Series)
 - 3. Parking Line and Driveway Paint: Hotline Waterborne Yellow (TM2153) (meets Federal Specification (FS) TTP-1952-F).
 - 4. All piping in mechanical rooms shall be painted in their entirety, in the following colors:
 - a. Gas lines: Orange
 - b. Domestic cold water: White
 - c. Domestic hot water: Pink
 - d. Heating hot water: Red
 - e. Condenser water: Green
 - f. Chilled water: Blue

- C. Interior Surfaces:
1. Gypsum Wallboard: (Epoxy):
 - a. Primer: One (1) coat ProMar 200 Zero VOC Latex Primer (B28W2600).
 - b. Finish: Two (2) coats Pro Industrial Waterbased Epoxy, Eg-Shel (B73 Series).
 - 1) Location: Kitchens, bathrooms, and laboratories.
 - OR
 - c. Finish: Two (2) coats Pro Industrial Pre-Catalyzed, Eg-Shel (K45 Series).
 - 1) Location: Corridors & Stairwells.
 2. CMU: (Epoxy):
 - a. Primer: Two (2) coats Heavy Duty Block Filler (B42W46)
 - b. Finish: Two (2) coats Pro Industrial Waterbased Epoxy, Eg-Shel (B73 Series).
 - 1) Location: Kitchens, bathrooms, and laboratories.
- D. Paint Types:
1. Paint Type (EPNT-1):
 - a. Number: Architect to provide at a later date.
 - b. Color: Architect to select from manufacturer's full range.
 - c. Location: Field.
 2. Paint Type (EPNT-2-5):
 - a. Number: Architect to provide at a later date.
 - b. Color: Architect to select from manufacturer's full range.
 - c. Location: Accent.

END OF SECTION 09 90 00

SECTION 10 01 00 - MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Furnish and install the following:
 - 1. Swimsuit dryer.
 - 2. Barrier free lift system.

1.3 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 04 20 00 - Unit Masonry.
- C. Section 05 50 00 – Metal Fabrications: Metal bracing, fasteners and other support components.
- D. Section 06 10 00 - Rough Carpentry: Wood blocking.
- E. Section 09 21 16 - Gypsum Board Assemblies.
- F. Section 09 51 00 - Acoustical Ceilings.
- G. Division 26 – Electrical Sections.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
 - 3. Manufacturer's operation and maintenance data, as applicable.
- B. Shop Drawings: Show sizes, locations and installation details. Include utility (electrical, water, gas) requirements.
- C. Samples: Color charts showing manufacturer's full range of colors.

1.5 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 00 – Project Management and Coordination.

1.6 COORDINATION

- A. Coordinate Work of this Section with Work of other sections in which items are to be installed.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Specifications are based on named products and manufacturers. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.

2.2 MATERIALS

- A. Swimsuit Dryer:
 - 1. Manual self-start and self-stop, no-heat high-speed spinning water extractor
 - 2. Size: 15 inches by 15 inches by 23 inches
 - 3. Weight: 55 pounds
 - 4. Construction: Rust-resistant stainless steel and plastic.
 - 5. Electrical: 1/3 HP, 120 VAC, 60 cycleUL approved
 - 6. Approved Product/Manufacturer: Suitmate Swimsuit Water Extractor manufactured by Extractor Corporation; South Elgin IL (800) 553-3353.
- B. Barrier Free Lift Systems:
 - 1. Lift System "1":
 - a. Description: Model V4 (400lb) Portable ceiling lift with 3-90 degree curves, 3-45 degree curves, 2 long rollers, Universal Sling with head support, installation hardware for all thread suspension.
 - b. Number/Location: As shown on drawings.
 - c. Approved Manufacturer: BHM Medical, Inc., as distributed by Home Elevator of Texas, Houston, TX; (713) 490-2330 or Architect approved equal by Medcare Products, inc., as distributed by K-Med, Inc., Sugar Land, TX; (281) 980-2844.
 - 2. Lift System "2":
 - a. Description: Transverse System with model V4 (400lb) portable unit, ceiling lift, 110 feet of straight track, 32 feet of reinforced track, transverse rollers, 2 long rollers for portable unit, installation hardware with threaded rod suspension, one Universal sling with head support.
 - b. Number/Location: As shown on drawings.
 - c. Approved Manufacturer: BHM Medical, Inc., as distributed by Home Elevator of Texas, Houston, TX; (713) 490-2330 or Architect approved equal by Medcare Products, inc., as distributed by K-Med, Inc., Sugar Land, TX; (281) 980-2844.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify utility (electrical, water, and gas) requirements, where applicable, are installed and ready for connection.
- B. Verify items fastened to walls have proper blocking or support items installed.
- C. Verify locations for items are ready for their installation.

3.2 INSTALLATION

- A. Install all items in accordance with manufacturer's printed instructions in locations shown on drawings or otherwise indicated.

3.3 CLEANING AND ADJUSTING

- A. Make final adjustment after installation and clean all backstop support piping of dirt and other substances which may affect final finish.

- B. Clean all items of dirt and foreign matter which may affect appearance and operation.
- C. Adjust items for proper operation.
- D. Instruct Owner's personnel on proper operation and maintenance of items.

END OF SECTION 10 01 00

SECTION 10 11 00 – MARKERBOARD AND TACKBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Markerboards.
 - 2. Tackboard.
 - 3. Display Rails.
 - 4. Accessories necessary for a complete installation.

1.3 DEFINITIONS

- A. Comparable Product: Product demonstrated and approved through submittal process, or where indicated as a produce substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.4 SUBMITTALS

- A. Product Data: Technical data for each type of product including construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
 - 1. Include electrical characteristics for motorized units.
- B. Shop Drawings: Submit plans, elevations, sections, details, and attachment to other work.
 - 1. Indicate sizes and layout, method of attachment, accessories, trim, details and finish.
 - 2. Show locations of panel joints. Show locations of field assembled joints for factory fabricated units too large to ship in one piece.
 - 3. Show locations and layout of special purpose graphics.
 - 4. Include sections of typical trim members.
 - 5. Include wiring diagrams for power and control wiring.
- C. Samples: Submit for each type of visual display unit indicated.
 - 1. Visual Display Panel: Not less than 8-1/2 inches by 11 inches (215 mm by 280 mm), with facing, core, and backing indicated for final work. Include one panel for each type, color, and texture required.
 - 2. Trim: 6 inch (150 mm) long sections of each trim profile.
 - 3. Display Rail: 6 inch (150 mm) long section of each type.
 - 4. Rail Support System: 6 inch (152 mm) long sections.
 - 5. Accessories: Full size Sample of each type of accessory.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Surface Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: 25 or less.

- b. Smoke Developed Index: 450 or less.
- 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
- B. Installer Qualifications: Entity having minimum 5 years documented experience that employs installers and supervisors who are trained and approved by manufacturer.
- C. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.
- D. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical shown on Drawings. Include accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Preinstallation Conference: Conduct conference at site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
 - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.8 WARRANTY

- A. Porcelain Enamel Face Sheets: Written warranty in which Manufacturer agrees to repair or replace porcelain enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - c. Noticeable deterioration of finish.
 - d. Writing surface delamination.

- e. Fabric discoloration, tearing, or delamination.
- f. Unit releasing from substrate.

2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Porcelain Enamel Face Sheet: PEI-1002, with face sheet two or three coat process.
- B. High Pressure Plastic Laminate: NEMA LD 3.
- C. Natural Cork Sheet: Seamless, single layer, compressed fine grain cork sheet; bulletin board quality; face sanded for natural finish with surface burning characteristics indicated.
- D. Plastic Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout with surface-burning characteristics indicated.
- E. Vinyl Fabric: Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than 13 oz./sq. yd. (440 g/sq. m); with surface burning characteristics indicated.
- F. Polyester Fabric: Nondirectional weave, 100 percent polyester; weighing not less than 15 oz./sq. yd. (508 g/sq. m); with surface-burning characteristics indicated.
- G. Hardboard: ANSI A135.4, tempered.
- H. Particleboard: ANSI A208.1, Grade M-1.
- I. Medium Density Fiberboard: ANSI A208.2, Grade 130.
- J. Fiberboard: ASTM C 208 cellulosic fiber insulating board.
- K. Clear Tempered Glass: ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- L. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.
- M. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
- N. Primer/Sealer: Mildew resistant primer/sealer recommended in writing by visual display unit manufacturer for intended substrate.

2.2 MARKERBOARD AND TACKBOARD

- A. Manufacturers listed whose products meet or exceed the specifications are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.
 - 1. Aarco Products, Inc.
 - 2. ADP Lemco Incorporated, (ALinc).

3. Best Rite Manufacturing.
 4. Claridge Products and Equipment, Inc.
 5. Marsh Industries, Inc.
 6. Platinum Visual Systems.
- B. Markerboard: Factory fabricated.
1. Basis of Design: Claridge LCS³
 2. Assembly: Indicated on Drawings.
 3. Corners: Square
 4. Width: As indicated on Drawings.
 5. Height: As indicated on Drawings.
 6. Mounting Method: Direct to wall, ensure wood blocking is provided in wall for mounting.
- C. Markerboard Panel: 24 gauge porcelain enamel steel LCS 24 face sheet on 7/16 inch MDF core with 0.015 inch aluminum back sheet.
1. Color: White.
 2. Magnetic.
- D. Tackboard Panel: Vinyl fabric faced panel on core indicated.
1. Basis of Design: Claridge Fabricork series #1550EW or comparable product.
 2. Fabric Wrapped Edge: Wrap edge of tackboard panel with fabric facing.
 3. Thickness: 1/2 inch (12.7 mm)
 4. Color and Pattern: Selected by Architect.
- F. Tackstrips (TS):
1. 1/4" thick layer of 100% natural cork laminated to 1/4" thick layer of hardboard
 2. Include push pins
 3. Size: 4 feet long by 1-3/4 inches wide
 4. Locations: As shown on drawings or required.
- G. Aluminum Frames: Fabricated from not less than 0.062 inch (1.57 mm) thick, extruded aluminum; standard size and shape
1. Basis of Design: Claridge Series 1 or comparable product
 2. Field Applied Trim: Snap on trim with no visible screws or exposed joints.
 3. Aluminum Finish: Clear anodic finish.
 4. Color and Pattern: Selected by Architect.
- H. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board as indicated on approved Shop Drawings.
- I. Combination Assemblies: Provide H trim between abutting sections of visual display panels.
- J. Chalktray: Continuous.
1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast aluminum end closures.
 2. Solid Type: Extruded aluminum with ribbed section and smoothly curved exposed ends.
- K. Display Rail: Extruded aluminum display rail with plastic impregnated cork insert, end stops, and continuous paper holder, designed to hold accessories.
1. Basis of Design Manufacturer/Product: Claridge 74 EZ Deluxe Map and Display Rail or comparable product.
 2. Size: 2 inches (50 mm).
 3. End Stops: Claridge 75ES or comparable product.

- L. Flag Holder: Claridge #76 FH or equal. Two for each room- total, not two per board.
- M. Flag Holders & Map Hooks:
 - 1. For 16'-0" marker boards: Two (2) aluminum flag holders & four (4) aluminum map hooks.
 - 2. For 8'-0" marker boards: Two (2) aluminum flag holders & four (4) aluminum map hooks.
 - 3. For 4'-0" marker boards: Four (4) aluminum map hooks.
- N. Tackboards: Four (4) aluminum map hooks.
- O. Tackboard Insert Color: Selected by Architect.
 - 1. Aluminum Color: Match finish of visual display assembly trim.

2.3 FINISH REQUIREMENTS

- A. Comply with NAAMM *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Aluminum Finishes:
 - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - 2. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
 - 3. Baked Enamel or Powder Coat Finish: AAMA 2603, except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the work.
- B. Examine roughing in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation. Clean substrates of substances, such as dirt, mold, and mildew, that impair the performance of and affect the smooth, finished surfaces of visual display boards.

- B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
 - 1. Moisture Content: Maximum of 4 percent when tested with an electronic moisture meter.
 - 2. Prepare substrates indicated to receive glass writing surfaces required by manufacturer's written instructions to achieve a smooth, dry, clean, structurally sound surface that is uniform in color.
 - a. Gypsum Board: Prime gypsum board with primer as recommended in writing by primer/sealer manufacturer and glass writing surface manufacturer.
 - b. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- C. Prime wall surfaces indicated to receive visual display units and as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.
- D. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION

- A. Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Install clear silicone caulk along entire top edge of all markerboards and tackboards where they meet the wall.
- C. Factory Fabricated Visual Display Board Assemblies: Adhere to wall surfaces with egg size adhesive gobs at 16 inches (400 mm) o.c., horizontally and vertically.
 - 1. Field Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal clips. Attach trim to boards with fasteners at maximum 24 inches (610 mm) o.c.
 - 2. Mounting Height: Install visual display units at mounting heights indicated on Drawings, or if not indicated, at heights indicated.
 - a. Mounting Height for Grades K through 3: 24 inches (610 mm) above finished floor to top of chalktray.
 - b. Mounting Height for Grades 4 through 6: 28 inches (711 mm) above finished floor to top of chalktray.
 - c. Mounting Height for Grades 7 and Higher: 36 inches (914 mm) above finished floor to top of chalktray.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION 10 11 00

SECTION 10 14 00 - GRAPHICS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Room identification signs.
 - 2. Exterior dimensional letter signage.
 - 3. Dedication plaque.
 - 4. Accessories necessary for a complete installation.
- B. Allowance: Signage is affected by allowances. Refer to Section 01 21 00.

1.3 SUBMITTALS

- A. Product Data: Technical data for each type of signage.
- B. Signage Shop Drawings: Submit fabrication and installation details and attachments to other Work.
 - 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 2. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Dedication Plaque Shop Drawings: Submit fabrication and installation details and attachments to other Work.
 - 1. Indicating materials, sizes, and finishes, details of fabrication and installation, fasteners and hardware, attachments, related and adjacent Work.
 - 2. Rubbing of actual pattern of cast metal plaque for Architect's approval prior to casting.
- D. Certifications: Submit letter of certification from manufacturer that installer and manufacturer is in compliance and meets specified requirements.
- E. Samples:
 - 1. One (1) 6 inch x 6 inch sample of cast metal plaque material with specified finish.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code/City Code: Comply with building code and local ordinances for exterior signage.
 - 2. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.

- B. Installer Qualifications: Installer has minimum 5 Years documented experience in the manufacture of signage and who employs installers and supervisors trained and approved in installation methods for each type of signage.
- C. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.6 WARRANTY

- A. Written warranty signed by manufacturer in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design Manufacturer: Riot Creative Imaging; (713) 988-9200. Other manufacturers shall have a minimum of five (5) years' experience manufacturing products meeting or exceeding those specified and shall comply with Division 1 requirements for substitutions in order to be considered.
 - 1. A.R.K. Ramos Architectural Signage Systems; (405) 235-5505.
 - 2. InPro Corporation (IPC); (800) 2222-5566.
 - 3. ProWorx Architectural Signage; (713) 666-3131.
 - 4. South Texas Graphics; (713) 467-4499.
 - 5. Stanley Signature Signs; (281) 395-6106.
 - 6. The Southwell Co.; (210) 223-1831.
- B. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- C. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- D. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- E. Acrylic Sheet: ASTM D 4802, category standard with manufacturer for each sign, Type UVF (UV filtering).
- F. Plastic Laminate Sheet: NEMA LD 3, general purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.

- G. Vinyl Film: UV resistant vinyl film of nominal thickness indicated, with pressure sensitive, permanent adhesive on back; die cut to form characters or images indicated and suitable for exterior applications.
- H. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.
- I. Accessories:
 - 1. Fasteners and Anchors: As necessary for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
 - a. Use concealed fasteners and anchors unless indicated to be exposed.
 - b. Exposed Metal Fastener Components: Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - 2. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
 - 3. Adhesive: Recommended by sign manufacturer.
 - 4. Two Face Tape: High bond, foam core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.
 - 5. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D 1187.

2.2 SIGNAGE

- A. Room Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Laminated Sheet Sign: Photopolymer face sheet with raised graphics laminated over subsurface graphics to acrylic backing sheet to produce composite sheet.
 - a. Color(s): Selected by Architect.
 - 2. Sign Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Beveled.
 - b. Corner Condition in Elevation: Square.
 - 3. Frame: Aluminum.
 - a. Profile: Square.
 - b. Corner Condition in Elevation: Square.
 - c. Finish and Color: Painted, matte black color.
 - 4. Mounting: Surface mounted to wall with concealed anchors.
 - 5. Text and Typeface, Panel and Photo Polymer Signs: Accessible raised characters and Braille. Finish raised characters to contrast with background color, and finish Braille to match background color.
 - a. Raised Characters: Characters and Grade 2 Braille raised **1/32 inch (0.8 mm)** above background, uppercase, sans serif, minimum 5/8 inch to maximum 2 inch high (no decorative, italic, bold, oblique, script) with contrasting colors on symbols and text only.
 - b. Braille: Domed or rounded shape; below corresponding text.
 - c. Pictograms: Field height of minimum 6 inches; no characters or braille in pictogram field; nonglare, field contrast to pictogram, text descriptors below pictogram field
 - d. Accessibility Symbols: Where used, symbols shall comply with International Accessibility Symbols.
- B. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles:

1. Character Material: Cast aluminum.
2. Character Height: Indicated on Drawings.
3. Finishes:
 - a. Baked Enamel or Powder Coat Finish: Color to match school colors and logo.
 - b. Overcoat: Baked on clear coating.
4. Mounting: Concealed studs.
5. Typeface: Selected by Architect.

2.3 DEDICATION PLAQUE

- A. Cast Metal Dedication Plaque:
 1. Material and Fabrication:
 - a. Casting: Prime bronze ingots of Alloy 220 Commercial bronze free of pits and gas holes and all letters shall be sharp and hand tooled.
 - b. Border Style: Single line standard border design.
 - c. Letter Style/Sizes: Shall be Helvetica Medium in both upper and lower case letters, unless shown otherwise. Letter sizes shall be as shown on drawings.
 - d. Finishes:
 - 1) Borders and Letter Faces: satin finish.
 - 2) Plaque Background: Pebble texture finish with baked on acrylic coating.
 - 3) Plaque shall be chemically cleaned.
 - 4) Completed plaque shall be sprayed with two (2) coats of clear hardened acrylic polyurethane.
 - e. Size: As shown on drawings.
 2. Fasteners and Attachment Hardware: Concealed fasteners and hardware of size and type recommended by manufacturer for attachment of plaque on brick wall where indicated on drawings.
 3. Provide all materials required for a complete installation.
 4. Approved Manufacturers:
 - a. A.R.K. Ramos Architectural Signage Systems, Oklahoma City, OK; (405) 235-5505
 - b. Best Manufacturing Sign Systems, Montrose, CO; (800) 235-2378
 - c. York Bronze Company, Bryan, TX; (800) 488-4662
 - d. Gemini Incorporated, Cannon Falls, MN; (800) 538-8377
 - e. Matthews Bronze, Pittsburgh, PA; (800) 950-1317
 - f. Metal Arts, Division of L & H Mfg. Co., Mandan, ND; (800) 237-8069
 - g. ProWorx Architectural Signage, Houston, Texas; (713) 666-3131
 - h. The Southwell Co., San Antonio, TX; (210) 223-1831 (Basis of Specification).

2.4 FABRICATION

- A. Provide sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 5. Internally brace signs for stability and for securing fasteners.
 6. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing Work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
 7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket mounted signs to suit sign construction and mounting conditions indicated. Modify brackets as necessary.
1. Aluminum Brackets: Factory finish brackets with baked enamel or powder coat finish to match sign background color unless otherwise indicated.

2.5 FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.
- E. Aluminum Finishes:
1. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.
 2. Baked Enamel or Powder Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of signage Work. Verify sign support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- B. Proceed with installation after correcting unsatisfactory conditions.

3.2 INSTALLATION

- A. Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 3. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
 - a. Comply with all applicable accessibility requirements for mounting height and location of each sign.
 4. Before installation, verify sign surfaces are clean and free of materials or debris that impair installation.
 5. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 2. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
 3. Shim Plate Mounting: Provide 1/8 inch (3 mm) thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using method specified above.
- C. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.
- D. Cast Metal Dedication Plaque:
1. Install in accordance with manufacturer's instructions.
 2. Install in location shown on drawings.
 3. Install with concealed fasteners of threaded bolt screwed into back of plaque and inserted into hole drilled in brick at an angle and filled with cement.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 14 00

SECTION 10 21 13 – SOLID PLASTIC (HDPE) TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Toilet partitions.
 - 2. Urinal screens.
 - 3. Entrance screens.
 - 4. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Technical data for each type of product including construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Submit plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of cutouts for compartment-mounted toilet accessories.
 - 2. Show locations of reinforcements for compartment-mounted grab bars.
 - 3. Show locations of centerlines of toilet fixtures.
 - 4. Show ceiling grid and overhead support or bracing locations.
- C. Samples: Submit for each type of unit with samples of hardware and accessories involving material and color selection.
- D. Maintenance Data: Submit data to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
 - 2. Surface Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame Spread Index: 26 to 75.
 - b. Smoke Developed Index: 450 or less.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

1.6 MAINTENANCE MATERIAL

- A. Furnish extra materials that match products installed and packaged with protective covering for storage and identified with labels describing contents and source.
 - 1. Door Hinges: One hinge(s) with associated fasteners.
 - 2. Latch and Keeper: One latch and keeper(s) with associated fasteners.
 - 3. Door Bumper: One bumper(s) with associated fasteners.
 - 4. Door Pull: One door pull(s) with associated fasteners.
 - 5. Fasteners: Ten fasteners of each size and type.

1.7 WARRANTY

- A. Furnish twenty-five year limited warranty for panels, doors, and stiles against breakage, corrosion, delamination, and defects in factory workmanship.
- B. Furnish one-year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design Manufacturer (TP-1): General Partitions; an ASI Group company. Other manufacturers are subject to compliance with requirements.
 - 1. Solid Plastic (HDPE) (TP-1):
 - a. Accurate Partitions Corp.; ASI Group.
 - b. Ampco Products, LLC.
 - c. Bobrick Washroom Equipment; (214) 340-6400.
 - d. Bradley Corporation; (800) 272-3539.
 - e. Global Partitions; ASI Group
 - f. Inpro Corporation; (800) 222-5556.
 - g. Metpar Corp./Sanymetal
 - h. Scranton Products; Capitol Partitions, Comtec Industries.
- B. Aluminum Castings: ASTM B 26/B 26M.
- C. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
- D. Stainless Steel Sheet: ASTM A 666, Type 304, stretcher leveled standard of flatness.
- E. Stainless Steel Castings: ASTM A 743/A 743M.

2.2 PARTITION COMPONENTS

- A. Solid Plastic Partitions:
 - 1. Style:
 - a. Toilet Partition: Floor anchored and overhead braced.
 - b. Entrance Screen Style: Floor supported and overhead braced.
 - c. Urinal Screen Style: Floor anchored.
- B. Door, Panel, Screen, and Pilaster Construction: Solid, high density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, no sightline system, and with homogenous color and pattern throughout thickness of material.
 - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.

2. Heat Sink Strip: Continuous, stainless steel strip fastened to exposed bottom edges of solid plastic components to hinder malicious combustion.
 3. Color and Pattern: Selected by Architect from manufacturer's full range.
 4. Panel and Pilaster Brackets:
 - a. Continuous heavy duty anodized extruded aluminum (6063-T5 alloy) wall brackets are pre-dilled. Wall brackets are mounted with stainless steel, vandal-resistant screws. The attachment of brackets to the adjacent wall construction shall be accomplished with 2 1/2" stainless steel resistant screws and plastic anchors.
- C. Urinal Screen Post: Post design of stainless steel matching the thickness and construction of pilasters or 1-3/4 inch (44 mm) square, aluminum tube with satin finish; with shoe and sleeve (cap) matching that on the pilaster.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Heavy duty operating hardware and accessories.
1. Hinges: 16-gauge continuous piano, self-closing hinge. Continuous piano hinge shall be attached to door and stile by theft resistant, pin-in-head Torx stainless steel machine screws into factory installed, threaded brass inserts. Fasteners secured directly into the core are not acceptable.
 2. Latch and Keeper: Heavy duty surface mounted cast stainless steel latch unit designed to resist damage due to slamming, with combination rubber faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through bolts.
 3. Coat Hook: Heavy duty combination cast stainless steel hook and rubber tipped bumper, sized to prevent in swinging door from hitting compartment mounted accessories. Mount with through bolts.
 4. Door Bumper: Heavy duty rubber tipped cast stainless steel bumper at out swinging doors and entrance screen doors. Mount with through bolts.
 5. Door Pull: Heavy duty cast stainless steel pull at out swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through bolts.
- B. Overhead Bracing: Continuous, extruded aluminum head rail with antigrip profile and in standard finish.
- C. Anchorages and Fasteners: Exposed fasteners of stainless steel, finished to match the being secured, with theft resistant type heads. Provide sex type bolts for through bolt applications. For concealed anchors, use stainless steel, hot dip galvanized steel, or rust resistant, protective coated steel compatible with related materials.

2.4 FABRICATION

- A. Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead Braced Units: Provide corrosion resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Floor Anchored Units: Provide corrosion resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- D. Urinal Screen Posts: Provide corrosion resistant anchoring assemblies with leveling adjustment nuts at tops and bottoms of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.

- E. Door Size and Swings: Unless otherwise indicated, provide 24 inch (610 mm) wide, in swinging doors for standard toilet compartments and 36 inch (914 mm) wide, out swinging doors with a minimum 32 inch (813 mm) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the work. Confirm location and adequacy of blocking and supports required for installation. Proceed with installation after correcting unsatisfactory conditions.

3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch (13 mm).
 - b. Panels and Walls: 1 inch (25 mm).
 - 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
 - a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
 - 3. Full Height (Continuous) Brackets: Secure panels to walls and to pilasters with full height brackets.
 - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor Anchored Units: Set pilasters with anchors penetrating not less than 2 inches (51 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out swinging doors to return doors to fully closed position.

END OF SECTION 10 21 13

SECTION 10 28 13 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Public use washroom accessories.
 - 2. Public use shower room accessories.
 - 3. Private use bathroom accessories.
 - 4. Warm air dryers.
 - 5. Childcare accessories.
 - 6. Underlavatory guards.
 - 7. Custodial accessories.
 - 8. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Technical Data including construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 1. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 2. Include electrical characteristics.
- B. Samples: Full size, for each exposed product and for each finish specified.
 - 1. Approved full size Samples will be returned and may be used in the Work.
- C. Product Schedule: Show types, quantities, sizes, and installation locations by room of each accessory required. Identify locations using room designations indicated.
- D. Maintenance Data: Submit for inclusion in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Source Limitations: Obtain products from single source from single manufacturer.

1.5 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 WARRANTY

- A. Mirrors: Written warranty signed by manufacturer in which manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Toilet accessories schedule is based on Bobrick Washroom Equipment unless noted otherwise. Subject to compliance with requirements, provide products by one of the following:
 - 1. AJW Architectural Products.
 - 2. American Specialties, Inc.
 - 3. Bobrick Washroom Equipment, Inc.
 - 4. Bradley Corporation.
 - 5. Brey-Krause Manufacturing Co.
 - 6. GAMCO Specialty Accessories; a division of Bobrick.
 - 7. Tubular Specialties Manufacturing, Inc.
- B. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- C. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- D. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- E. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot dip zinc coating.
- F. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot dip galvanized after fabrication.
- G. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear glass mirrors, nominal 6.0 mm thick.

2.2 COMPONENTS

- A. Underlavatory Guard: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
 - 1. Material and Finish: Antimicrobial, molded plastic, white.

2.3 FABRICATION

- A. Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of [six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items. Remove temporary labels and protective coatings. Clean and polish exposed surfaces according to manufacturer's written recommendations.

PART 4 - SCHEDULE

4.1 ACCESSORY SCHEDULE

- A. TA-1 - Soap Dispensers:
 - 1. Mounting: Surface.
 - 2. Model No.: B-2112.
 - 3. Locations: All lavatories.
- B. TA-2 - Mirrors:
 - 1. Mounting: Surface.
 - 2. Model No.: B-290.
 - 3. Size: 24 inches by 36 inches (600 mm by 900 mm), unless shown otherwise.
 - 4. Location: All lavatories.
- C. TA-3 - Toilet Paper Dispensers:
 - 1. Mounting: Surface.
 - 2. Model No.: B-265.
 - 3. Locations: All water closets.
- D. TA-4 - Paper Towel Dispensers:
 - 1. Model No.: B-262.
 - 2. Locations: All lavatories.
- E. TA-5 - Grab Bars: (At Typical Accessible Toilet Stalls)
 - 1. Size/Finish: 1-1/2 inch diameter satin stainless steel.
 - 2. Clearance: 1-1/2 inch between rail and wall.
 - 3. Model No.: B-6806.
 - 4. Mounting: Attach with concealed mounting kit. Mount parallel to floor.

5. Location: Accessible water closets and toilet stalls.
- F. TA-6 - Sanitary Napkin Dispensers:
1. Mounting: Surface.
 2. Model No.: B-2706.
 3. Operation: Single coin / Double coin - (25/50 cents).
 4. Capacity: 20 Napkins/ 30 Tampons.
 5. Locations: Women's toilet room.
- G. TA-7 - Sanitary Napkin Disposal:
1. Mounting: Surface.
 2. Model No.: B-270.
 3. Locations: Women's toilet rooms.
- H. TA-8 Mop and Broom Holder:
1. Mounting: Surface.
 2. Model No.: B-239 x 34.
 3. Capacity: Four hooks, three mop holders.
 4. Locations: Mop sink at each custodial rooms.
- I. TA-9 - Grab Bars: (At Accessible Shower)
1. Mounting: Surface.
 2. Model: B-6861 modified (24 x 16).
 3. Locations: Accessible shower stalls.
- J. TA-10 - Folding Benches: Adult Height:
1. Mounting: Surface, reversible.
 2. Models: B-5181.
 3. Locations: Accessible shower stalls.
- K. TA-10 - Folding Benches, Child Height (15 inch (375 mm) seat height):
1. Mounting: Surface, reversible.
 2. Models: Bradley 9561.
 3. Locations: Accessible shower stalls.
- L. TA-11 - Clothes Hook:
1. Mounting: Surface.
 2. Model Model No.: B-6717; or equivalent.
 3. Location: One (1) hook inside door at single toilet rooms, and one (1) hook at each shower location if not included in partition package described below, unless noted otherwise.
 4. Masonry Wall Installation: Provide fiber plugs or expansion shields for use with sheet-metal screws furnished or provide 1/8" (3 mm) toggle bolts or expansion bolts.
 5. Toilet and Shower Partitions: If toilet and shower partitions are utilized, hooks are to be provided by the partition manufacturer(s) as part of their hardware package.
- M. TA-12 - Shower Curtains, Rods and Hooks:
1. Rods: B-047 (36 inches or as indicated).
 2. Curtains: B-204-2 (42 inches x 72 inches or as required).
 3. Hooks: B-204-1.
 4. Mounting/Locations: Accessible shower stalls.
- N. TA-13 - Electric Hand Dryers:
1. Mounting: Semirecessed, maximum 3-9/16 inch recess.
 2. Model No.: B-750, white.

3. Voltage: 120 volt, single phase.
 4. Location: Refer to drawings.
- O. TA-14 - Paper Towel Dispenser/Trash Receptacle Combination
1. Mounting: Surface.
 2. Model No.: B-3949.
 3. Locations: Refer to drawings.
- P. TA-15 - Grab Bars: (At Additional Accessible Toilet Stalls)
1. Size/Finish: 1-1/2 inch diameter satin stainless steel, lengths as indicated in drawings.
 2. Clearance: 1-1/2 inch between rail and wall.
 3. Model No.: B-6806.
 4. Mounting: Attach with concealed mounting. Mount parallel to floor.
 5. Location: Accessible water closets and toilet stalls.
- Q. TA-16 - Diaper Changing Stations:
1. Type: Horizontal station to accommodate infants and toddlers.
 2. Construction and Features:
 - a. FDA approved injection molded polypropylene with steel on steel hinge system. Fabricate to withstand static loads over 400 pounds.
 - b. Child protection straps with snap lock fasteners.
 - c. Built in diaper bag hooks.
 - d. Built in sanitary liner dispensers; 3 ply, biodegradable.
 - e. Premium gas spring mechanism.
 - f. Molded usage and safety instructions in six languages and Braille.
 - g. ADA compatible.
 - h. Antifungal to comply with ASTM standards.
 3. Color: Selected by Architect.
 4. Dimensions: 35 inches long by 22 inches high by 4 inches deep (875 mm by 550 mm by 100 mm).
 5. Approved Product/Manufacturer: Koala Bear Kare Baby Changing Stations, Model KB 200, manufactured by Koala Bear Kare.
- R. TA-17 - Trash Receptacle
1. Mounting: Recessed
 2. Model No.: B3644.
 3. Locations: Refer to drawings.
- S. TA-18 – Electric, Swivel Head, Hand Dryers:
1. Basis of Design: Model DR-5708 as manufactured by GAMCO Specialty Accessories; a division of Bobrick.
 2. Mounting: Surface.
 3. Voltage: 115 volt, single phase.
 4. Location: Refer to drawings.
- T. TA-19 – Electric Swimsuit Spinner:
1. Mounting: Surface.
 2. Model Name: SUITMATE by Extractor Corp
 3. Power: 115 volt, 20 amp, 60 Hz.
 4. Locations: Refer to drawings.

END OF SECTION 10 28 13

SECTION 10 44 00 - FIRE EXTINGUISHER AND CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Fire extinguisher.
 - 2. Extinguisher cabinet.
 - 3. Defibrillator (AED) Cabinet.
 - 4. Brackets.
 - 5. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and technical data to indicate specification compliance.
 - 2. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specifications are based on the products of named manufacturers. Other listed manufacturers who produce products equivalent to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent to those specified and comply with Division 1 requirements regarding substitutions to be considered.
 - 1. Larsen's Manufacturing Co.
 - 2. The Williams Bros. Corporation of America.
 - 3. J. L. Industries, Inc.
 - 4. Nystrom, Inc.
 - 5. Potter-Roemer.

2.2 MATERIALS

- A. Fire Extinguisher Cabinets (FEC):
 - 1. Size: 24 inches x 9-1/2 inches x 6 inches inside tub dimension.
 - 2. Type: Semi-recessed with 2-1/2 inch return trim rolled edge; ADA compliant.
 - 3. Tub Construction: 22 gauge min. steel with standard baked acrylic enamel interior finish.
 - 4. Door and Frame: 18 gauge min. 304 stainless steel door and frame with vertical decal lettering "FIRE EXTINGUISHER" in red color, unless directed otherwise by Architect.
 - 5. Glazing: clear acrylic "Duo" vertical glazing panel
 - 6. Hardware: Continuous concealed piano hinge constructed of material which matches door and trim material. Satin finish pull handle with cam cylinder lock with safety pull designed to release upon firm pull on handle (Larsen's "Larsen-Loc"™, J.L. Industries "Saf-T-Lok"™; or equivalent).
 - 7. Bracket: Hook type; Larsen's #546, or equal.
 - 8. Finish of Exterior: #4 Stainless steel.

9. Fire rating: as occurs, provide fire rated cabinet, for one or two hour rated conditions as indicated or required by specific location. Cabinet shall be tested and approved by Warnock Hersey to ASTM E-814, and shall bear the Warnock Hersey label.
- B. Fire Extinguishers (F.E):
 1. Models/Types:
 - a. Multipurpose dry chemical with 10 lbs. capacity and UL 4A-80B:C rating conforming to MP10 Series.
 2. Mounting: Provide eye brackets for direct wall mounting to hook and for mounting in Fire Extinguisher cabinets. Refer to drawings for location and quantity.
 3. Provide initial inspection tag for each extinguisher.
- C. Defibrillator (AED) Cabinet (for Owner-furnished AED):
 1. Basis of Design: J. L. Industries, Inc. 1400 Series steel cabinet.
 2. Mounting: Fully or semi-recessed, as indicated on drawings. Surface mounted units are not acceptable.
 3. Door: Fully glazed with acrylic glazing, continuous hinge, "AED" and symbolic heart graphics, roller catch, and plated metal handle.
 4. Alarm: Battery-operated, with on/off key switch on exterior of cabinet.
 5. ADAC-compliant.
 6. Size: Large enough to accommodate most AEDs, but at least 14 inches x 14 inches by 7 inches deep net inside dimensions.
 7. Finish: White powder coat.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fire extinguishers and cabinets in openings in accordance with manufacturer's printed instructions.
- B. Install fire extinguishers and cabinets where indicated on the drawings, or if not indicated, in locations required by governing code and as directed by Owner.

END OF SECTION 10 44 00

SECTION 10 51 26 - SOLID PLASTIC LOCKERS AND BENCHES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Shop Drawings: Show all required field measurements, all details and elevations, plans and sections required to indicate all conditions, and dimensioned drawings of hardware.
- C. Samples:
 - 1. Actual samples or color charts indicating manufacturer's full line of colors for Architect's selection and approval.
 - 2. Actual samples of each item of hardware.
- D. Certification: Manufacturer's written certification indicating compliance with building code authorities having jurisdiction regarding to the use of the material on the Project as it applies to the use of "plastic in a commercial building".

1.2 WARRANTY

- A. Warrant the work specified herein for ten (10) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials or workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Rapid deterioration of finish.
 - 2. Loose or missing parts.
 - 3. Nonfunctioning components and mechanisms.
 - 4. Rust, delamination, warp, rot or breakage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer (LC-1 & 2): Columbia Partitions. Other manufacturers must have a minimum of five (5) years experience manufacturing products equivalent to those specified and comply with Division 1 regarding substitution requirements to be considered.
 - 1. Lockers:
 - a. Solid Polymer (HDPE) LenoxLocker by Bradley Corp.; (800) 272-3539.
 - b. HDPE Solid Plastic Lockers by Third Dimension Division 10 Solid Plastic Specialties; (570) 969-0623.
 - c. Aquamax by List Industries, Inc.; (800) 776-1342.
 - d. Polylife® Lockers by Columbia Lockers (Div. of PSI, Inc.); (866) 337-7286.
 - e. Aquarian HDPE Lockers by Penco Products; (88) 562-1000.
 - f. Tufftec® Lockers by Scranton Products; (800) 445-5148.
 - g. ASI Storage Solutions, 2171 Liberty Hill Road, Eastanollee, GA 30538; (706) 827-2720.
 - 2. Benches:
 - a. Any approved locker manufacturer listed above.

2.2 LOCKER MATERIALS

- A. Panels:
 - 1. Material: Solid Polymer high density polyethylene (HDPE) with homogeneous color throughout
 - 2. Doors and frames: 1/2 inch thick
 - 3. Sides, shelves, tops and backs: 3/8 inch thick
 - 4. Slope tops: 1/4 inch thick
- B. Hinges:
 - 1. Stainless steel (Type 304 or better) or continuous solid plastic
 - 2. Size: Minimum 2 inches, 14 gauge
 - 3. Number: Three (3) for doors over 42 inches high
 - 4. Plastic engraved number plates with two (2) colors.
 - 5. Latch Device: Continuous and/or padlockable
 - 6. Padlock locking
- C. Equipment:
 - 1. Single tier lockers shall have one (1) hat shelf 10 inches below the top of locker.
 - 2. Single tier lockers 12 inches and larger in width shall have two (2) single prong wall hooks. (Solid plastic)
- D. Padlocks:
 - 1. Types: Provide key controlled with back case stamping and control chart.
 - 2. Manufacturer: Master Lock Company, No. 1525 (as approved by Architect - submit samples).
 - 3. Color: As selected by Architect from manufacturer's standard colors.
- E. Schedule:
 - 1. Type "LC-1":
 - a. Type: Solid Plastic Lockers - Double tier.
 - b. Size: 18 inches wide x 18 inches deep x 36 inches high (72 inches total height).
 - c. Doors: Solid with vents.
 - d. Locks: Hasp with bolt.
 - e. Backs and Dividers: Solid.
 - f. Ends: Solid.
 - g. Base: As scheduled and detailed.
 - h. Top: Sloped.
 - i. Location: Girls and Boys Locker Rooms.
 - j. One (1) ADA-compliant lockers at each bank of lockers.
 - 2. Type "LC-2":
 - a. Type: Solid Plastic Lockers - Single tier
 - b. Size: 18 inches wide x 18 inches deep x 72 inches high
 - c. Doors: Solid with vents
 - d. Locks: Hasp with bolt.
 - e. Backs and Dividers: Solid
 - f. Ends: Solid
 - g. Base: As scheduled and detailed
 - h. Top: Sloped
 - i. Location: Coaches Locker Room.
 - j. One (1) ADA-compliant lockers at each bank of lockers.

2.3 SOLID POLYMER BENCHES

- A. Material: HDPE locker benches.
- B. Size: 1-3/8 inch thick x width and length shown on drawings.
- C. Pedestals: 16 inch high PVC pedestals located at 30 inches to 36 inches o.c. at locations indicated on drawings.
- D. Attachment Hardware: Non-corrosive materials of type and size recommended by manufacturer to suit application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Assemble and install lockers and benches in accordance with manufacturer's written instructions. Lockers shall have no sharp edges. Install lockers in the locations shown on the Drawings.
- B. Install number plates in order as shown on Drawings.
- C. Install locker doors to close smoothly and completely without binding. Ensure hinges do not bind.

END OF SECTION 10 51 26

SECTION 10 56 13 – PLASTIC STORAGE SHELVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Four post plastic storage shelving.
 - 2. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Technical data for each type of shelving unit and accessory components including recessed tracks. Include rated capacities, installation and construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Submit plans, elevations, sections, and details, including installation details of connectors, lateral bracing, and special bracing.

1.4 COORDINATION

- A. Coordinate sizes and locations of blocking and backing required for installation of metal storage shelving attached to wall and ceiling assemblies.
- B. Coordinate locations and installation of storage shelving that may interfere with ceiling systems including lighting, HVAC, speakers, sprinklers, access panels, electrical switches or outlets, and floor drains.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install storage shelving until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for building occupants during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 STORAGE SHELVING UNITS

- A. Four Post Plastic Storage Shelving:
 - 1. Basis of Design Manufacturer: Nexel Industries, Inc. or comparable product as approved by Architect.
 - 2. Shelf Frame and Posts: Blue metallic epoxy powder coat electrostatically applied over zinc chromate electro plating and chemical conversion undercoat.
 - 3. Shelf Mats: Polymer composition, vented open grid surface.
 - 4. Shelf Clips: 2 part tapered plastic sleeve.

2.2 ANCHORS

- A. Floor Anchors: Galvanized steel, post installed expansion anchors or power actuated fasteners. Provide number per unit recommended by manufacturer unless additional anchors are indicated in calculations.
- B. Wall Anchors: Galvanized steel anchors designed to secure metal storage shelving to adjacent wall. Provide one per shelving unit for each shelving unit adjacent to a wall unless additional anchors are indicated in calculations.

2.3 FABRICATION

- A. Fabricate storage shelving components to provide field assembled units that are square and rigid, with posts plumb and true and shelves flat and free of dents or distortion. Fabricate connections to form a rigid structure, free of buckling and warping.
 - 1. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
 - 2. Build in straps, plates, brackets, and other reinforcements as needed to support shelf loading.
 - 3. Cut, reinforce, drill, and tap fabrications to receive hardware, fasteners, and similar items.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of the work. Examine floors for suitable conditions where storage shelving will be installed.
- B. Examine walls and ceilings to which storage shelving will be attached for properly located blocking, grounds, or other solid backing for attachment of support fasteners.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Vacuum and clean finished floor over which storage shelving is to be installed.

3.3 INSTALLATION

- A. Install storage shelving level, plumb, square, rigid, true, and with shelves flat and free of dents or distortion. Make connections to form a rigid structure, free of buckling and warping.
 - 1. Install exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 2. Install braces, straps, plates, brackets, and other reinforcements as needed to support shelf loading and as required for stability.
 - 3. Adjust post base bolt leveler to achieve level and plumb installation.
 - 4. Anchor shelving units to floor with floor anchors through floor plate. Shim floor plate to achieve level and plumb installation.
 - 5. Connect side to side and back to back shelving units together.
 - 6. Install shelves in each shelving unit at spacing indicated on Drawings.
 - a. Four Post Metal Storage Shelving: Install four clips, one at each post, for support of each shelf; with clips fully engaged in post perforations.

3.4 ERECTION TOLERANCES

- A. Erect four post storage shelving to a maximum tolerance from vertical of 1/2 inch (13 mm) in up to 10 feet (3 m) of height, not exceeding 1 inch (25 mm) for heights taller than 10 feet (3 m).

3.5 ADJUSTING

- A. Adjust storage shelving so that connectors and other components engage accurately and securely.
- B. Adjust and lubricate operable components to operate smoothly and easily, without binding or warping. Check and readjust operating hardware.
- C. Touch up marred finishes or replace storage shelving that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by metal storage shelving manufacturer.
- D. Replace storage shelving components that have been damaged beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 56 13

SECTION 10 73 13 - ALUMINUM CANOPY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to
 1. Fixed canopy.
 2. Accessories necessary for a complete application.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of Texas, using performance requirements and design criteria indicated.
- B. System Performance: Provide canopy system that has been designed, produced, fabricated and installed to withstand normal temperature changes as well as live loading, dead loading and wind loading in compliance with building code requirements:
 1. Live Load: 20 psf minimum.
 2. Structural Design for Wind Forces: Comply with ANSI A58.1.
 3. Base Mean Wind Velocity: 120 mph, Exposure Classification C.
 4. Importance Factor: 1.0.
 5. Stability Criteria: Comply with applicable building codes.
 6. Design structural members to meet minimum deflection criteria of L/180.
 7. Design footings for maximum bearing pressure of 1,500 psf.
- C. Provide structure capable of sustaining severe icing, hail, hurricane force winds and supporting concentrated load such as being walked upon.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, specifications, component performance data and installation instructions.
- B. Shop Drawings: Submit detailed drawings, layout of canopy system, bent locations, mechanical joint locations with complete details, connections, jointing and accessories. Include details of tube anchorage.
- C. Samples: Color charts showing full range of colors.
- D. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible in the jurisdiction of the project, for their preparation.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: International Building Code.
 - 2. AWS (American Welding Society) standards for structural aluminum welding.
- B. Installer Qualification: Firm with not less than 5 years experience in installation of aluminum sunshades of type, quantity and installation methods similar to work of this section.
- C. Source Limitations: Obtain aluminum covered walkway system from single source.
- D. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication where possible, to insure proper fitting of work.
- E. Allow for adjustments within specified tolerations wherever taking of field measurements before fabrication might delay work.
- F. Shop Assembly: Preassemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- G. Coordination: Coordinate work of this section with work of other sections which interface with sunshade system (building structure, building finishes, etc.).

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. As scope and performance documents, the Drawings and Specifications do not necessarily indicate or describe all Work required for the performance and completion of the Work. Contracts will be let on the basis of such documents with the understanding that the Provide the items required for proper completion of the Work without adjustment to price or schedule. Work shall be of sound, quality construction and the Contractor shall be solely responsible for the inclusions of adequate labor and materials to cover the proper and timely fabrication and installation of the aluminum walkway cover indicated, described, or implied.
- B. As a performance specification, the criteria for the solution of structurally sound aluminum walkway cover indicated on the Drawings or specified herein are the sole purpose of defining the design intent and performance requirements. The details shown are intended to emphasize the acceptable profiles and performance requirements for this Project. To avoid any misunderstanding or lack of interpretation, the Contractor is hereby advised that the responsibility for the aluminum walkway cover is totally his and that designs and resolutions proposed in the Contractor's shop drawings, structural calculations, and related documentation shall be demonstrated throughout the Work and warranty period specified or required.
- C. Design proposal submissions which follow exactly the details indicated on the Drawings for the aluminum walkway cover, will not relieve the Contractor of his responsibility for the design, fabrication, erection, or performance of the Work of this Section.
- D. In the event of a controversy over the design, the decision of the Architect will take precedence.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle sunshade system components as recommended by manufacturer. Handle and store in a manner to avoid deforming members and to avoid excessive stresses.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design Product: Avadek Walkway Covers: Subject to compliance with requirements, provide canopies by one of the following:
 - 1. Aluminum Techniques, Inc.; (281) 499-9026.
 - 2. East Texas Canopy.
 - 3. Mapes Industries, Inc. Lincoln, NE; (800) 228-2391.
 - 4. Peachtree Protective Covers, Inc.
 - 5. Jones Aluminum Inc.
 - 6. Airvent Remodeling & Design Center, Houston, TX
 - 7. American Walkway Covers, LLC, Pompano Beach, FL
 - 8. Dittmer Architectural Aluminum, Winter Springs, FL
 - 9. Perfection Architectural Systems, Inc., Orlando, FL
 - 10. Superior Metal Products Co., Birmingham, AL
 - 11. Texas Aluminum Industries, Inc., Houston, TX
- B. Aluminum Extrusion: ASTM B221 alloy 6063 heat treated to T-6 temper.
- C. Aluminum Sheet: ASTM B209, minimum 0.032 inch thickness.
- D. Finish: Satin anodize 204-R1 meeting Aluminum Association Specification AA-M-10C-22A-21.
- E. Structure shall be designed by the manufacturer to withstand walking on top, heavy hail, and winds in the configurations shown on drawings.
- F. Fasteners:
 - 1. Deck Screws: Type 18-8 non-magnetic stainless steel sealed with a neoprene "O" ring beneath 5/8 inch (7 mm) outside dimension, conical washer. Rivets are not permitted.
 - 2. Fascia Rivets: Size 3/16 inch by 1/2 inch (4 mm by 13 mm) grip range aluminum rivets with aluminum mandrel.
 - 3. Bolts, Nuts, and Washers: 18-8 non-magnetic stainless steel.
 - 4. Tek Screws: Not permitted.
- G. Beam/Deck connection flashing (Bird cover): .080" thick metal flashing at all beams.
- H. Provide concealed drainage from deck into columns.
- I. Roof Deck: Shall be of size and depth recommended by the manufacturer to suit application, intended use, requirements of building code authorities having jurisdiction.
- J. Expansion Joints: Expansion joints shall have no metal to metal contact.
- K. Horizontal U-Beams and vertical tube columns shall be sizes recommended by the manufacturer to suit application, intended use, and requirements of building code authorities having jurisdiction, and shall be attached with concealed fasteners.

2.2 FABRICATION

- A. Comply with indicated profiles, dimensioned requirements, and structural requirements. Provide minimum 6 inch by 10 inch (150 mm by 250 mm) structural bents. Provide fascia as indicated.

- B. Use sections true to details with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength and durability.
- C. Mechanical Joints: Consisting of stainless steel bolts with minimum of 2 bolts per fastening. Install bolts and nuts concealed utilizing 1/2 inch thick by 1-1/2 inch (13 mm by 44 mm) aluminum bolt bars welded to structural members.
- D. Detail mechanical joints on shop drawings showing each location.
- E. Roof Deck: Extruded aluminum shapes, interlocking self flashing sections. Shop fabricate to lengths and panels widths required for field assembly. Depth of sections to comply with structural requirements. Provide shop induced camber in deck units with spans greater than 16 feet to offset dead load deflections. Use welded dams at non-draining ends of deck.
- F. Expansion joints, design structure for thermal expansion and contraction. Provide expansion joints as required.
- G. Provide exposed rivets for fastening bottom of fascia to deck to match fascia finish.
- H. Apply shop applied dip coat of clear acrylic enamel to each column end terminating in concrete to insulate from electrolytic reaction. Pierce column ends to "key" grout to bent for maximum uplift protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for supporting members, blocking, inserts, installation tolerances, and other conditions affecting performance of the work.
- B. Confirm locations, dimensions and elevations shown on shop drawings prior to fabrication.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.2 INSTALLATION

- A. Erection: Set walkway support tube frames onto steel channels projecting from bidding structure; set to required elevations, align, plumb and level; secure tube frame to structural channels. Comply with manufacturer's instructions.
- B. Erection: Set roof support frames (bents) into pockets provided in top of footings; set to required elevations, align, plumb and level; and grout in place with 2,000 psi. portland cement grout. Ensure grout fills voids and keys to columns. Fill downspout units with grout to bottom of discharge level. Install aluminum deflectors after grouting. Match to finish and elevation of adjacent sidewalks.
- C. Install roof deck sections, accessories, and related flashing in accordance with manufacturer's instructions. Provide roof slope for rain drainage without ponding water. Align and anchor roof deck units to structural support frames.

3.3 FLASHING

- A. Flashings: Flashings required between covered walkway system and adjoining structures are not work of this section. Refer to 07 62 00.

3.4 CLEANING AND PROTECTION

- A. Damaged Units: Replace roof deck panels and other components of the work that have been damaged or have deteriorated beyond successful minor repair.
- B. Cleaning: Remove protective coverings at time in project construction sequence that provide greatest protection of work. Clean finished surfaces to comply with recommendations of manufacturer.
- C. Protection: Protect completed work ensuring walkway cover will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 10 73 13

SECTION 10 73 26 - WALKWAY COVERINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to
 1. Prefabricated aluminum covered walkways.
 2. Accessories necessary for a complete application.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ladders and countertop supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. System Performance: Provide sunshade system that has been designed, produced, fabricated and installed to withstand normal temperature changes as well as live loading, dead loading and wind loading in compliance with building code requirements for geographic area in which work is located and as follows:
 1. Live Load: 20 psf minimum.
 2. Structural design for wind forces: Comply with ANSI A58.1.
 3. Base Mean Wind Velocity: 144 mph, Exposure Classification C.
 4. Importance Factor: 1.0.
 5. Stability Criteria: Comply with applicable building codes.
 6. Design structural members to meet minimum deflection criteria of L/180.
 7. Design footings for maximum bearing pressure of 1,500 psf.
- C. Sizes shown on Drawings are considered minimum.
- D. Provide structure capable of sustaining severe icing, hail, hurricane force winds and supporting concentrated load.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.4 SUBMITTALS

- A. Product Data: Technical data, specifications, component performance data, and installation instructions.
- B. Shop Drawings: Submit detailed drawings, layout of walkway system, clearances, bent locations, mechanical joint locations with complete details, connections, jointing, attachments, and accessories. Include details of tube anchorage.
- C. Samples: Color charts showing full range of colors.

- D. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Calculations: Provide signed and sealed structural calculations for the proposed walkway cover, by a professional engineer registered in the State of Texas and who professes his discipline to be structural engineering.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Building Code: Applicable provisions of the International Building Code.
 - 2. AWS (American Welding Society) standards for structural aluminum welding.
- B. Installer Qualification: Firm with not less than 5 year documented experience in installation of aluminum sunshades of type, quantity and installation methods similar to work of this section.
- C. Source Limitations: Obtain aluminum covered walkway system from single source.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle sunshade system components as recommended by manufacturer. Handle and store in a manner to avoid deforming members and to avoid excessive stresses.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of prior to preparation of shop drawings and fabrication. Allow for adjustments within specified tolerations wherever taking of field measurements before fabrication might delay work.

1.8 WARRANTY

- A. Written warranty signed by manufacturer, Installer, and Contractor in which manufacturer agrees to repair or replace covered walkway assembly and its components that fail in materials or workmanship within specified warranty period.
 - 1. Defects shall include, but not be limited to:
 - a. Loose or missing parts.
 - b. Delamination or deterioration of finish.
 - c. Scratched, dented, and damaged surfaces.
 - 2. Warranty Period: One year from date of Substantial Completion.
- B. Finish Warranty: Written warranty signed by manufacturer in which manufacturer agrees to repair or replace components on which finishes does not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Basis of Design: Avadek Walkway Cover, Subject to compliance with requirements, provide canopies by one of the following
 - 1. Avadek Walkway Cover Systems & Canopies.

2. Aluminum Technologies, Inc.
 3. E. L. Burns Co.
 4. East Texas Canopy.
 5. Mapes Industries, Inc.
 6. Peachtree Protective Covers, Inc.
- B. Aluminum Extrusion: ASTM B221 alloy 6063 heat treated to T-6 temper.
- C. Aluminum Sheet: ASTM B209, minimum 0.032 inch thickness.
- D. Finish: Satin anodize 204-R1 meeting Aluminum Association Specification AA-M-10C-22A-21.
- E. Beam/Deck connection flashing (Bird cover): .080" thick metal flashing at all beams. Provide bird protection devices at underside of all canopies. Typical locations will be where fluted roof decks cross over support beams.
- F. Fasteners:
1. Deck Screws: Type 18-8 non-magnetic stainless steel sealed with a neoprene "O" ring beneath 5/8 inch (7 mm) outside dimension, conical washer. Rivets are not permitted.
 2. Fascia Rivets: Size 3/16 inch by 1/2 inch (4 mm by 13 mm) grip range aluminum rivets with aluminum mandrel.
 3. Bolts, Nuts, and Washers: 18-8 non-magnetic stainless steel.
 4. Tek Screws: Not permitted
- G. Miscellaneous Materials:
1. Nonshrink, Nonmetallic Grout: Factory packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.
 2. Elastomeric Joint Sealant: Multicomponent nonsag urethane joint sealant complying with requirements in Section 079200.
 3. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- H. Foundation and Footings: Design and construct foundations in accordance with governing codes and ordinances.
1. Concrete: ACI 316, comply with requirements of Section 033000 or site mixed concrete consisting of 5 sacks of Portland cement complying with ASTM C150, per cubic yard of wet concrete combined with fine aggregate, clean water, and mixed in proportions to attain minimum 28 day compressive strength of not less than 3,000 psi.

2.2 FABRICATION

- A. Comply with indicated profiles, dimensioned requirements, and structural requirements. Provide minimum 6 inch by 10 inch (150 mm by 250 mm) structural bents. Provide fascia as indicated.
- B. Use sections true to details with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength and durability.
- C. Mechanical Joints: Consisting of stainless steel bolts with minimum of 2 bolts per fastening. Install bolts and nuts concealed utilizing 1/2 inch thick by 1-1/2 inch (13 mm by 44 mm) aluminum bolt bars welded to structural members.
1. Provide exposed rivets for fastening bottom of fascia to deck to match fascia finish.
 2. Provide concealed drainage from deck into columns.
- D. Flashing: 0.040 inch aluminum fabricated to prevent leakage of water between canopy and adjacent structures, where applicable.

- E. Walkway Deck: Extruded Aluminum shapes, interlocking self flashing sections. Shop fabricate to lengths and panels widths required for field assembly. Depth of sections to comply with structural requirements. Provide shop induced camber in deck units with spans greater than 16 feet to offset dead load deflections. Use welded dams at nondraining ends of deck.
- F. Expansion Joints: Design structure for thermal expansion and contraction. Provide expansion joints as required with no metal to metal contact.
- G. Size horizontal U beams and vertical tube columns recommended by manufacturer for application and to comply with requirements.
 - 1. Attached with concealed fasteners.

2.3 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - 1. Color: Clear.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for supporting members, inserts, installation tolerances, and other conditions affecting performance of the work.
- B. Confirm locations, dimensions and elevations shown on shop drawings prior to fabrication.
- C. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Shop Assembly: Preassemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

3.3 INSTALLATION

- A. Set walkway support tube frames onto steel channels projecting from bidding structure; set to required elevations, align, plumb and level; secure tube frame to structural channels. Comply with manufacturer's instructions.
- B. Set roof support frames (bents) into pockets provided in top of footings; set to required elevations, align, plumb and level; and grout in place with portland cement grout. Ensure grout fills voids and keys to columns. Fill downspout units with grout to bottom of discharge level. Install aluminum deflectors after grouting. Match to finish and elevation of adjacent sidewalks.
 - 1. Provide column sleeves and set to elevations and dimensions on approved shop drawings.
 - 2. Install columns and beams straight and true.
- C. Install walkway deck sections, accessories, and related flashing in accordance with manufacturer's instructions. Provide roof slope for rain drainage without ponding water. Align and anchor roof deck units to structural support frames.
 - 1. Install raincaps over draining sections of the deck. Fill downspouts columns with grout to discharge level to prevent standing water. Install downspout deflectors after grouting.
- D. Flashings: Flashings required between covered walkway system and adjoining structures are not work of this section.

3.4 CLEANING AND PROTECTION

- A. Damaged Units: Replace roof deck panels and other components of the work that have been damaged or have deteriorated beyond successful minor repair.
- B. Cleaning: Remove protective coverings at time in project construction sequence that provide greatest protection of work. Clean finished surfaces to comply with recommendations of manufacturer.
- C. Protection: Protect completed work ensuring walkway cover will be without damage or deterioration at time of Substantial Completion.

END OF SECTION 10 73 26

SECTION 10 75 16 – GROUND-SET FLAGPOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Ground set flagpoles made from aluminum.
 - 2. Fittings, base, anchorage.
 - 3. Flags.
 - 4. Accessories necessary for a complete installation,

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, currently licensed to practice within jurisdiction of the project location, with experience in the design of curtainwalls and aluminum storefronts to design ground set flagpoles using performance requirements and design criteria indicated.
- B. Seismic Performance: Flagpole assemblies shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- C. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.
 - 1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location when flying two flags is indicated on the Structural Engineer's Drawings.
 - 2. Base flagpole design on polyester, nylon or cotton flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

1.4 SUBMITTALS

- A. Product Data: Technical data for flagpoles including construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: Submit plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support, including section, and details of foundation system.
- C. Delegated Design Submittal.
- D. Operation and Maintenance Data: Submit data to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Accessibility Requirements: Comply with applicable requirements.
 - a. United States Access Board Americans with Disabilities Act Accessibility Guidelines (ADAAG) (2010 ADA Standards for Accessible Design).

- b. ICC A117.1 Accessible and Useable Building and Facilities.
- c. Texas Accessibility Standards (TAS) 2012 or United States Access Board Americans with Disabilities Act Accessibility Guidelines (ADAAG) (2010 ADA Standards for Accessible Design).

- B. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme/Lingo Flagpoles, LLC.
 - 2. American Flagpole.
 - 3. Baartol Company.
 - 4. Carrot-Top Industries, Inc.
 - 5. Eder Flag Manufacturing Company, Inc.
 - 6. Ewing Flagpoles.
 - 7. Morgan-Francis Flagpoles and Accessories.
 - 8. Pole-Tech Company Inc.
 - 9. U.S. Flag & Flagpole Supply, LP.

2.2 ALUMINUM FLAGPOLES

- A. Aluminum Flagpoles: Cone tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M, Alloy 6063, with a minimum wall thickness of 3/16 inch (4.8 mm).
- B. Exposed Height: 25 feet (7.5 m).
- C. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
 - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
 - 2. Provide flush hairline joints using self aligning, snug fitting, internal sleeves.
- D. Metal Foundation Tube: Corrugated steel foundation tube, 0.060 inch (1.52 mm) wall thickness with 3/16 inch (4.8 mm) steel bottom plate and support plate; 3/4 inch (19 mm) diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
 - 1. Flashing Collar: Same material and finish as flagpole.
- E. Sleeve for Aluminum Flagpole: Fiberglass or PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.
 - 1. Flashing Collar: Same material and finish as flagpole.
- F. Cast Metal Shoe Base: Made from aluminum with same finish and color as flagpoles for anchor bolt mounting; furnish with anchor bolts.
 - 1. Furnish ground spike.

- G. Hinged Baseplate: Cast metal tilting hinged base and anchor plate joined by permanently secured pivot rod. Furnish with stainless steel screws for securing tilting base to anchor plate when not tilted; furnish with anchor bolts.
 - 1. Finish: Same as flagpole.
 - 2. Furnish aluminum base or aluminum flashing collar finished to match flagpole.
 - 3. Furnish ground spike.
- H. Pivoting Tilt Base: Steel baseplate with channel or rectangular tube uprights, pivot bolt, and locking device for tilting flagpole. Furnish tilting flagpole with steel counterweight box and weights, or furnish with internal counterweight. Furnish base with anchor bolts.
 - 1. Finish: Same as flagpole.
 - 2. Furnish ground spike.

2.3 FITTINGS

- A. Finial Ball: Flush seam ball, sized to match flagpole butt diameter.
 - 1. 0.063 inch (1.6 mm) spun aluminum, finished to match flagpole.
- B. Internal Halyard, Winch System: Manually operated winch with control stop device and removable handle, stainless steel cable halyard, and concealed revolving truck assembly with plastic coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
 - 1. Halyard Flag Snaps: Chromium plated bronze or stainless steel or bronze or nylon swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.
- C. Internal Halyard, Cam Cleat System: 5/16 inch (8 mm) diameter, braided polypropylene halyard; cam cleat; and concealed revolving truck assembly with plastic coated counterweight and sling. Furnish flush access door secured with cylinder lock. Finish truck assembly to match flagpole.
 - 1. Halyard Flag Snaps: Chromium plated bronze or stainless steel or bronze or nylon swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.
- D. External Halyard: Ball bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16 inch (8 mm) diameter, braided polypropylene halyard and 9 inch (228 mm) cast metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
 - 1. Halyards and Cleats: One at each flagpole.
 - 2. Cleat Covers: Cast metal, finished to match flagpole, secured with cylinder locks.
 - 3. Halyard Covers: 2 inch (50 mm) channel, 60 inches (1500 mm) long, finished to match flagpole.
 - 4. Halyard Flag Snaps: Chromium plated bronze or stainless steel or bronze or nylon swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.
 - 5. Plastic Halyard Flag Clips: Made from injection molded, UV stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Furnish two per halyard.
 - a. Manufacturers: Subject to compliance with requirements, provide products by Acme/Lingo Flagpoles, LLC.

2.4 MISCELLANEOUS MATERIALS

- A. Flag: One 6'-0" x 10'-0" US flag and one 6'-0" x 10'-0" Texas or United States of America flag.
- B. Concrete: Quick set concrete composed of not less than five (5) sacks of Portland cement conforming to ASTM C150, per cubic yard of wet concrete combined with fine aggregate, clean water, and mixed in proportions to attain minimum 28 day compressive strength of not less than 3,000 psi.

- C. Nonshrink, Nonmetallic Grout: Factory packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.
- D. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
- E. Sand: ASTM C 33/C 33M, fine aggregate.
- F. Elastomeric Joint Sealant: Single component nonsag urethane joint sealant complying with requirements in Section 079200.
- G. Bituminous Paint: Cold applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.5 FINISH

- A. Aluminum:
 - 1. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.
 - 2. Clear Anodic Finish: AAMA 611, AA-M12C22A41.
 - 3. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44.
 - a. Color: Selected by Architect.
 - b. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
 - 4. Gold Anodic Finish: AAMA 611, AA-M32C22A43; gold color.
 - 5. Baked Enamel or Powder Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - a. Color and Gloss: Selected by Architect.
 - 6. High Performance Organic Finish: Two coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Color and Gloss: Selected by Architect.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.
- E. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.

- F. Anchor Bolts: Locate and secure anchor bolts in forms with templates and by tying to reinforcement.
- G. Concrete: Place concrete as specified in Section 03 30 00. Compact concrete in place by using vibrators. Moist cure exposed concrete for no fewer than seven days or use nonstaining curing compound.
- H. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.2 FLAGPOLE INSTALLATION

- A. Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.
- B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch (50-mm) layer of elastomeric joint sealant and cover with flashing collar.
- C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.
- D. Provide positive lightning ground.

3.3 CLEANING AND ADJUSTING

- A. Clean area of debris and place excavated soil where directed or remove from site as directed. Clean flagpole of dirt and foreign matter which will affect appearance.
- B. Touch up damage to finished surfaces with manufacturer's matching paint.
- C. Adjust fittings for smooth operation.

END OF SECTION 10 75 16

SECTION 11 31 00 – RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Refrigeration appliances.
 - 2. Appliance coordination including service connections, supply lines, and power.
 - 3. Accessories necessary for a complete installation.

1.3 SUBMITTALS

- A. Product Data: Technical data including product specifications, installation, and maintenance instructions.
- B. Product Certificates: Submit certificate from product manufacturer stating compliance with requirements and intended use of product.
- C. Warranties: Submit manufacturer warranty indicated product is warranted in a light commercial application.
- D. Operation and Maintenance Data: Submit for each residential appliance to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NFPA: Provide electrical appliances listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 2. UL and NEMA: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.
 - 3. Energy Ratings: Provide energy efficient appliances that carry labels indicating energy cost analysis (estimated annual operating costs) and efficiency information.
 - 4. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) 2010.
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS) 2012.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for product's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

- C. Source Limitations: Obtain light commercial appliances from single source and each type of light commercial appliance from single manufacturer.
- D. Preinstallation Conference: Conduct conference at site.

1.5 WARRANTY

- A. Warranties: Written warranty signed by manufacturer in which manufacturer of the specific appliance specified agrees to repair or replace appliances or components that fail in materials or workmanship within specified warranty period.
 - 1. Provide appliance and equipment rated for light commercial grade or higher. Residential appliances are not acceptable unless manufacturer warrants residential units in a commercial application and only with Architect's approval.
- B. Refrigerator and Freezer, Sealed System: Full warranty, including parts and labor, for on site service on the product.
 - 1. Warranty Period for Sealed Refrigeration System: Five years from date of Substantial Completion.
 - 2. Warranty Period for Other Components: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 APPLIANCES

- A. Manufacturers: Provide basis of design product or comparable by one of the specified manufacturers.
 - 1. BSH Home Appliances Corporation (Bosch).
 - 2. BSH Home Appliances Corporation (Gaggenau).
 - 3. BSH Home Appliances Corporation (Thermador).
 - 4. Electrolux Home Products (Frigidaire).
 - 5. Follett Chewblet.
 - 6. General Electric Company (GE Appliances).
 - 7. Jenn-Air; a division of Whirlpool Corporation.
 - 8. KitchenAid; a division of Whirlpool Corporation.
 - 9. LG Electronics, Inc.
 - 10. Maytag; a division of Whirlpool Corporation.
 - 11. Manitowoc.
 - 12. Sears Brands LLC (Kenmore).
 - 13. Sub-Zero, Inc. (Sub-Zero and Wolf).
 - 14. Whirlpool Corporation.
- B. Undercounter Refrigerator:
 - 1. Basis of Design: General Electric GCE06GSHSB.
 - 2. Finish: Stainless steel.
 - 3. Capacity: 5.6 cu. ft.
 - a. Fresh Food: 5.1 cu. ft.
 - b. Freezer: 0.5 cu. ft.
 - 4. Dimensions:
 - a. Wide: 23-5/8 inches (584 mm).
 - b. Depth: 23-3/4 inches (584 mm).
 - c. Height: 34-1/8 inches (864 mm).
 - 5. Features:
 - a. Fresh food door shelves.
 - b. Vegetable crisper.

- c. In door can rack.
 - d. Manual defrost.
 - e. Front leveling legs.
 - f. Recessed handle.
 - 6. Refrigerant: R134A.
 - 7. ADA Compliant.
 - 8. Electrical Requirements: 115v volt; 60 Hertz, single phase, 8 amps; with 7 foot cord NEMA 5-15 plug.
- C. Under counter Ice Maker: ADA Compliant.
- 1. Basis of Design: Hoshizaki Am-50BAJ-AD
 - 2. Ice Maker: Air cooled.
 - a. Dimensions: 15" wide by 31.5 inches high.
 - b. Finish: Stainless steel.
 - c. Ice Production: 55 pounds per day.
 - d. Bin Capacity: 22 lbs
 - e. Refrigerant: R134a.
 - 3. Electrical Requirements: 115v volt; 60 Hertz, single phase, 8 amps; with 7 foot cord NEMA 5-15 plug.
- D. Appliances, Equipment, and Fixtures: Coordinate equipment, fixtures, appliances regardless which party provides or furnishes. Ensure adequate power supply and properly locate plumbing lines and hook ups, water and drain connections and accessories.
- E. Accessories: Provide accessories necessary for a working installation.

2.2 FINISHES

- A. Comply with NAAMM *Metal Finishes Manual for Architectural and Metal Products* for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Stainless Steel Finish: Provide appliances with standard finish complying with manufacturer's written instructions for surface preparation including ground and polished stainless steel surfaces for uniform, directionally textured finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with requirements for installation tolerances and conditions affecting performance of work. Coordinate installation of equipment, appliances, fixtures, and other items.
 - 1. Examine roughing in for piping systems and verify actual locations of piping connections before equipment installation.
 - 2. Examine electrical circuits and rating and verify locations and sufficient ratings for items requiring electrical power.
 - 3. Examine space to receive items and verify the space is of sufficient size and configuration for items.
- B. Proceed with installation after correcting unsatisfactory conditions.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions. Install fixtures level and plumb according to roughing in drawings.
- B. Power Supply: Coordinate power supply, grounding, outlets, and electrical wiring with locations indicated for appliances and equipment.
- C. Built in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
- D. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.
- E. Appliance Antitip Device: Install at each appliance according to manufacturer's written instructions.
- F. Utilities: Refer to plumbing and electrical sections for plumbing and electrical requirements.
- G. Connections and Hook ups: Coordinate location of services.
 - 1. Grounding: Ground equipment in accordance with applicable standards and code requirements.
 - 2. Wiring: Connect wiring in accordance with manufacturer recommendations.
 - 3. Provide necessary electrical outlets.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory authorized service representative:
 - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturer written recommendations. Certify compliance with each manufacturer appliance performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
- B. An appliance will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Test each equipment item to verify proper operation. Make necessary adjustments. Replace malfunctioning appliances and components, then retest. Repeat procedure until units operate properly.

3.4 TESTING AND ADJUSTING

- A. Test each equipment item to verify proper operation. Make necessary adjustments. Replace malfunctioning appliances and components, then retest. Repeat procedure until units operate properly.

3.5 CLEANING

- A. Clean equipment with manufacturers' recommended cleaning methods and materials. After completing installation of equipment and fixtures, inspect exposed finishes and repair damaged finishes. Remove packing materials from site.

3.6 PROTECTION

- A. Provide protective covering for installed appliances. Do not allow use of equipment items for temporary facilities.

3.7 DEMONSTRATION

- A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION 11 31 00

SECTION 12 24 00 - WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Window shades and accessories for room darkening.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Shop Drawings:
 - 1. Indicate field verified dimensions of openings scheduled to receive shades.
 - 2. Indicate fabric selection, operator, hardware style, and finish.
 - 3. Show location and installation procedures.
 - 4. Include details, attachments and clearances for Architect's approval.
- C. Samples or color charts showing manufacturer's full range of material colors for Architect's selection.

1.4 PRODUCT DELIVERY

- A. Deliver to job site in manufacturer's original cartons.
- B. Label shades with room and opening location in accordance with Room Finish Schedule.
- C. Carefully handle and store shades to prevent damage to materials, finishes, and operating mechanisms.

1.5 PROJECT CONDITIONS

- A. Install roller shades after finish work and ambient temperature, humidity and ventilation conditions are maintained at levels recommended for project upon completion.

1.6 PRODUCT DELIVERY

- A. Hardware and Shade Fabric: Draper's standard twenty-five year limited warranty.
- B. Motors and Controls: Draper's standard five year limited warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Specifications are based on LightBloc Zip XL System as manufactured by Draper; (765) 987-7999. Other manufacturers are not precluded from making a proposal on this Project, but to do

so, they must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions to be considered.

2.2 METHOD OF OPERATION

- A. Bead Chain Clutch: Bead chain and clutch operated, vertical roll-up, fabric, opaque window shade system, complete with headbox, side and sill channels for total opacity.

2.3 HARDWARE

- A. Rollers (except shades with spring rollers): Sizes 1-1/2 inch diameter with 0.065 inch wall or two (2) inch diameter with 0.080 inch wall of 6063-T5 aluminum extruded tube. Roller assembly easily removable.
- B. Roller Idler Assembly: Type 6/6 injected molded nylon and a zinc-plated cold rolled steel pin. Sliding pin for easy installation and removal of the roller.
- C. Endcaps: 1028 steel stamping, 3-1/4 inch x 3-3/4 inch, complete with roller adapter bracket. Installs to face, ceiling, or jamb as shown or required. Accepts snap-lock roller box cover and fabric guide. Clear anodized, black, white, ivory, or dark bronze baked enamel finish as selected by Architect.
- D. Head Box, Channels & Slat Bar: 6063-T5 aluminum custom extruded shapes, 0.060 inch wall. Clear anodized finish or black, white, ivory, or dark bronze baked enamel finish as selected by Architect. All contain grooves to accept light seal elements.
 - 1. Head Box: (Configuration shown or required)
 - a. For Surface or Jamb Installation (standard): Shall consist of an L-shaped back/top and an L-shaped front/bottom.
 - b. For Pocket Installation: Shall include a U-shaped back/top/front with removable bottom. Some exposed fasteners required.
 - 2. Side Channels: Shall be of one-piece construction. Channel consists of two (2) chambers. One (1) accepts the fabric and contains groove for fabric retainer. The second accepts the fabric guide and channel locator. Face-mounted units require plastic cover buttons.
 - 3. Sill Channel: Accepts the slat bar, prevents light leakage. Bottom of channel provides for use of flat head screws.
 - 4. Slat Bar: Shall be furnished with sill channel and is attached to the bottom of shade fabric. Includes a chamber for additional weight if needed for smooth operation. Does not retract into operator enclosure (headbox).
- E. Channel Locator: Type 6/6 injected molded nylon. Aligns enclosure and channels.
- F. Fabric Guides: Plated steel. Forms a transition for the fabric as it rolls into the channels, reducing friction.
- G. Patented Fabric Retention: Horizontal steel stays are installed at regular intervals and covered. At each end of stays, a grommet is installed through the stay and shade fabric. The grommets are then held within the side channels by fabric retainers. This system enables the shade to withstand reasonable air pressure differentials. Note-Extreme air currents or physical interference may cause product failure.
- H. Opacity Plates: 1018 steel with a rubber "O" ring. Installed on the endcaps of the roller box to eliminate light leakage.

2.4 OPAQUE WINDOW SHADE SYSTEM

- A. Operation Type: Motorized, vertical roll-up, fabric, opaque window shade system, complete with headbox, side and sill channels for total opacity; LightBloc ZIP™ XL FlexShade System as manufactured by Draper, Inc.
- B. Shade Motor and Control System:
 - 1. Standard Motor: 110 VAC, single phase, 60 HZ, instantly reversible, lifetime lubricated, and equipped with internal thermal overload protector, electric brake, and pre-set accessible limit switches. Tubular motor concealed inside each shade roller tube.
 - a. Group Control:
 - 1) ISO relay - UL listed component. One ISO relay per motor. Allows 110-120V group switching via toggle switch. Allows for up to 12 motors on one switch.
- C. Roller Tube: Fabricated from extruded aluminum, galvanized steel, or enameled steel. Diameter, wall thickness, and material selected by manufacturer to accommodate shade type and size. Fabric connected to the roller tube with LSE (low surface energy) double sided adhesive specifically developed to attach coated textiles to metal. Adhesive attachment to eliminate horizontal impressions in fabric.
- D. Headbox: Consists of extruded aluminum sections with endcaps and opacity plates.
 - 1. Size: 5 inches high by 5 inches wide by length required for shade being provided.
 - 2. U-shaped front, back, and top and removable bottom.
- E. Endcaps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size.
- F. Side Channels: Double chamber fabricated from 0.06 inch (1.5 mm) thick extruded aluminum sections. One chamber accepts fabric and contains groove for fabric retainer. Other chamber accepts fabric guide and channel locator.
- G. Sill channel: L bracket to prevent light leakage.
- H. Slat bar: Extruded aluminum bar attached to bottom of shade. Bar does not retract into headbox.
- I. Channel locator: Injected molded nylon insert to align side and sill channels with headbox.
- J. Fabric guide: Plated steel transition for fabric rolling into side channel.
- K. Fabric retainer: System designed to prevent disengagement of fabric from side channels due to normal variations of air pressure caused by doors opening, HVAC systems, and temperature differences between room and window well. System consists of horizontal steel stays installed in shade, covered with fabric, and spaced at regular intervals. Grommets installed through stays are held within groove of side channel chamber.
- L. Exposed aluminum finish:
 - 1. Finish: Black.

2.4 FABRICS

- A. Light-Filtering Fabrics
 - 1. SheerWeave Series SW2400 by Phifer: VOC Emissions: GREENGUARD Children & Schools -certified as a low emitting fabric. Manufacturer to supply GREENGUARD Children & Schools certificate. 500 denier fiberglass, vinyl coated and woven into a 2 x 2 basket weave. Fire rating: NFPA 701. Bacteria and Fungal Resistance: ASTM G 21 and ASTM G 22. Series SW2400, 3 percent open, .019 inches thick.
 - 2. Color and pattern: Charcoal.

- B. Room Darkening Fabrics
 - 1. SunBloc Series SB9000: Close woven fiberglass base textile with sun-resistant vinyl film bonded to each side, opaque with minimum tensile strength of 190 pounds for warp and 180 pounds for fill. Fire rating: NFPA 701 1006-Test 1. Washable and stain resistant. Wt. 12 oz/sq yd. Same color both sides, .015 inches thick.
 - 2. Color and pattern: Black.
- C. Color and pattern: As indicated in Color Schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Coordinate requirements for blocking, construction of shade pockets, and structural supports to ensure adequate means for installation of window shades.
- B. Coordinate installation of recessed shade pockets with construction of suspended acoustical panel ceilings specified in Division 9.
- C. Coordinate installation of recessed shade pockets with construction of suspended gypsum board ceilings specified in Division 9.
- D. Coordinate requirements for power supply conduit, and wiring required for window shade motors and controls.

3.3 INSTALLATION

- A. Install shades at locations scheduled, noted on the drawings, or as directed by the Architect in accordance with manufacturer's installation procedures, except as otherwise specified herein.
- B. Install intermediate support and extension brackets as needed to prevent deflection in headrail.
- C. Install shades with adequate clearance to permit smooth operation of shades and any sash operators. Hold shades 1/4 inch clear from each side of window opening on inside mount, unless other clearance is indicated.
- D. Provide 20 gauge, galvanized steel strap for anchoring.

3.4 CLEANING AND DEMONSTRATION

- A. Clean shades in accordance with manufacturer's instructions.
- B. Demonstrate shades to be in smooth uniform working order.

END OF SECTION 12 24 00

SECTION 13 11 00 - SWIMMING POOLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in the Table of Contents, shall be included in and made a part of this Section.

1.2 SUMMARY OF WORK *(for general guidance-not all inclusive)*

- A. Introduction
 - 1. Provide all labor, materials, equipment and services necessary to construct the following: (1) a competition pool, (2) a lesson pool, and (3) a dive pool (Alternate #2). This work shall include the structure(s) and installation of pool finishes as well as all products listed in Part 2 of Section 13 11 00.
- B. Work included in this section
 - 1. It is the intent of this section to place the entire responsibility for the construction of the pool(s) (including the construction of the pool shell(s)) under one vested CONTRACTOR. Under this section the Swimming Pool Contractor will provide but is not necessarily limited to the following:
 - a. Provide all equipment and services required for erection and delivery onto the premises of any equipment or apparatus provided. Remove equipment from premises when no longer required.
 - b. Layout, excavate, remove from the construction site, replace and grade materials as required beyond the limits of excavation of the pool shell(s) to complete the work described in this section. Reference Division 31 - Earthwork.
 - c. Grade and replace load bearing or high plasticity index soil, pump and dewater as necessary to keep excavations free from water during construction. Reference Division 31 - Earthwork.
 - d. Provide and maintain proper shoring and bracing for existing utilities, sewers and building foundations where required for related excavations. Reference Division 31 - Earthwork.
 - e. Provide all electrical conduit, wiring, junction boxes etc. to all low voltage pool equipment within pool filter/chemical rooms per Division 26 - Electrical. (Low voltage is considered less than 110 V.)
 - f. Coordinate for all required bonding and grounding of the pool shell, fittings, and equipment.
 - g. Provide all necessary piping and valving as shown on the drawings and specified herein.
 - h. Provide individually sized housekeeping pads for each pool pump. Provide housekeeping pads for pool equipment as required in the drawings.
 - i. Provide the main drain hydrostatic relief system and a sight sump as shown on the drawings. Reference Division 31 - Earthwork.

- j. Provide winterization products and services for the outdoor swimming pool(s) for a period not less than 12 months including a minimum of one (1) closing and one (1) opening. The Contractor shall provide one (1) additional opening if the outdoor facility is open for less than 40 days. Contractor to include winterization procedures with owner training.
 - k. Construct the cast in place or pneumatically applied concrete pool shell(s) and cast in place surge tank(s) as described in these specifications and detailed on the drawings, including reinforcement steel, inserts, fittings, main drain sumps and all embedded items (piping, anchors, etc.) for the pool(s). Reference Division 3 - Concrete and Structural. Before commencing the placement of concrete, verify electrical bonding of the pool embedded items and reinforcing steel. Also, coordinate and arrange any required electrical, plumbing and or building inspections. 31 - Earthwork.
 - l. Provide a proprietary aggregate cementitious finish in the pool(s) with a slip resistant surface with a vertical tile band. Provide specialty tile for the perimeter tile deck band, gutter nosing, wall targets, recessed steps, ramp entry to 18" water depth, floor lane markings, depth markings and warning signs, water polo markings, stanchion and water polo identification, construction joint installation bands and all other tile installation within the pool structures. Reference Section 131103 - Swimming Pool Tile - including the tolerance requirements for the concrete substrate.
 - m. Assemble and install the cleaning and maintenance equipment for the pool(s) as specified herein.
 - n. Provide for the storage of all pool related equipment, materials and systems. All items are the responsibility of the CONTRACTOR until accepted by owner.
 - o. Obtain final acceptance by jurisdictional health department(s).
 - p. Start, test, calibrate and adjust all mechanical equipment, electrical equipment, recirculation, chemical, and other supplied systems including deck, loose, maintenance, and safety equipment. Instruct the Owner's representative in the systems operation and maintenance as described herein.
 - q. Provide a one-year license and basic startup training for aquatic facility management application.
 - r. Provide the heater loop tee fittings in the pool recirculation lines, for each pool heat system.
- C. Related work specified in other sections
- 1. Section 131104 – Swimming Pool Cementitious Finish
 - 2. Section 131103 – Swimming Pool Tile
 - 3. Section 131106 – Swimming Pool Timing System
 - 4. The following work related to the swimming pools shall be completed by other trades.
 - a. Provide, erect and maintain all necessary barricades, signs, lights and flares for pool construction to protect workers and the public.
 - b. Provide and maintain proper shoring and bracing for existing utilities, sewers and building foundations where required for swimming pool related excavations. Reference Division 31 - Earthwork.

- c. Provide the under-drain system beneath the pool(s).
 - d. Provide sub-surface drainage beneath the pump pit and backwash pit. Reference Division 31 - Earthwork.
 - e. Construct pump pit and backwash pit including reinforcement, inserts, wall sleeves, anchors, access hatches, and fittings. Reference Division 3 - Concrete.
 - f. Prior to concrete pours, verify electrical bonding of the pool embedded items. Coordinate and arrange any required electrical, plumbing and or building inspections to be performed on embedded items. Reference Division 26 - Electrical.
 - g. Provide sanitary sewer and storm drain connections. Reference Division 22 - Plumbing.
 - h. Layout and install all deck mounted anchors, sockets, and inserts for the pool(s).
 - i. Provide deck finish beyond perimeter tile band. Reference Division 32 - Exterior Improvements.
 - j. Provide rules and regulations signage as required by code. Reference Division 1 - General Requirements.
 - k. Provide chlorine resistant caulking (sealant) and backer rod on pool decks. Reference Division 7 - Thermal and Moisture Protection.
- D. Related work specified in Plumbing section. Reference Division 22 - Plumbing. Work to be completed by other contractors.
- 1. Provide trench drains and area drains on pool deck.
 - 2. Provide sanitary sewer piping from the filter room including floor drains, sumps, and sump pump.
 - 3. Provide water service to all hose bibbs, flush hydrant boxes and auto-fill bypass to air gap above fill funnel(s). Install the slow closing solenoid valve(s) in the bypass auto-fill piping.
 - 4. Install Plumbing Contractor supplied water meter on the fresh water supply line upstream of the manual fill valve and the slow closing solenoid valve.
- E. Related work specified in Mechanical section. Reference Division 23 – HVAC. Work to be completed by other contractors.
- 1. Provide the heating system for the pool(s). Work to include all piping from the installed pool heating loop tees, heaters, booster pumps, controls, gauges, thermostats, control valves and wiring required to draw water from the recirculation line, heat the water and return it back to the recirculation line and interlock with pool recirculation pumps. Provide any related systems for supplemental pool water heating.
 - 2. Provide air recirculation systems for pool related spaces.
- F. Related work specified in Electrical sections. Reference Division 26 – Electrical. Work to be completed by other contractors.
- 1. Provide power to the exhaust fans for the chemical rooms.

2. Provide motor starters, auxiliary contacts, magnetic relays and other electrical control devices necessary for the complete operation of the pool systems. Install power to Variable Frequency Drive pool pump starters and power from VFD to the pool pump motor.
3. Ground and bond all pool structures, fittings and equipment in accordance with Article 680 of the N.E.C. Test and verify that the system electrical ground is true and solid. Provide certification to this effort.
4. Obtain permits, inspections, and approvals of all wiring including grounding and bonding of all metal components associated with the pool in accordance with Local, State and National Electrical Codes.
5. Install power, conduits, electrical boxes, and wiring for the Contractor furnished electronic timing and scoreboard system with multi-sport capability for race swimming, diving, water polo, pace clock, and synchronized swimming.
6. Install power, conduits, electrical boxes, and wiring for the Contractor furnished underwater lights and junction boxes.
7. Confirm all electrical conduits that penetrate the pool shell are watertight and installed per N.E.C. Article 680.

1.3 QUALITY ASSURANCE

- A. The specifications and drawings illustrate and detail three (3) swimming pool systems that shall be utilized for both competitive and recreational use. Certain technical aspects of the design are common only to pool systems planned for public use. Understanding these aspects, their functions and interaction through experience is vital to completing a successful operating system. It is a mandatory requirement that all bidders will have achieved such experience as a prerequisite for bidding this project.
1. CONTRACTOR to refer to section 002113 – INSTRUCTIONS TO BIDDERS for bonding requirements.
 2. If the Contractor has not received prior written approval for this project or has not been included in the pre-approved list of Contractors, they must submit a list of projects meeting the aforementioned qualifications, including contact information of the General Contractor shall be submitted for review and approval at least 10 days prior to bidding of the project. The Contractor must have completed at least five (5) public-use competition pools with individual water surface areas in excess of 6000 square feet and a depth of 12'-0" or more within the past 10 years.
 3. The Contractor must submit prior to the start of construction the name of the on-site Project Superintendent including their relevant experience. The Contractor's on-site Project Superintendent must have completed at least five (5) public-use competition pools with individual water surface areas in excess of 6000 square feet and a depth of 12'-0" or more within the past 10 years. A list of projects meeting the aforementioned qualifications, including contact information of the General Contractor as well as Owner shall be included with the experience submittal. Project Superintendent must not change on the project unless written authorization has been provided by the Architect and Owner.
 4. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligation of the contract and to complete the work described or if the bidder does not have the qualifications stated herein. Subject to compliance with item 2 above on this specification.

5. The following bidders have been pre-approved. All bidders shall meet the requirements listed above.

Acapulco Pools
Bernie Gall
1550 Victoria St. N.
Kitchener, Ontario N2B3EZ
Phone: 519 - 743-6357
Fax: 519-743-9698

Atlantis Aquatic Group
Terry Smith, Dennis Watson
7700 Hwy 71 West
Austin, TX 78735
p: 512.243.6877
f: 210.579.7308
e: terry@atlantisaquaticgroup.com

Progressive Commercial Pools, Inc.
Tim Phelps, Steve Davis
2510 Farrell Road
Houston, TX 77073
p: 512.848.4677
f: 281.443.1524
e: tphelps4@austin.rr.com

Sunbelt Pools
Rob Morgan, Jon Collins
10555 Plano Rd
Dallas, TX 75238-1305
p: 214.343.1133
f: 214.343.1201
e: robm@sunbeltpools.com

The Pool Company, Inc
Dwight Love
3077 20th St E, Suite D
Tacoma, WA 98424
p: 253.926.6875
f: 253.926.0590
e: dlove@thepoolcompanyinc.com

Wescon, Inc
Steve Kraft
4815 Hawkins St NE #C6
Albuquerque, NM 87109
p: 505.681.6150
f: 505.345.2512
e: wescon1@comcast.net

California Commercial Pools
David Jackson, Lee Jackson
2255 E Auto Center Dr
Glendora, CA 91713
p: 909.394.1280
f: 909.394.4579

1.4 REGULATORY AGENCY REQUIREMENTS AND ENGINEERING SERVICES

- A. The system shall comply with all necessary pre-construction approvals obtained by the Owner and Owner's Consultants from local regulatory agencies governing the design and construction of public swimming pools.
- B. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, and other costs in connection with his work, including the filing of all necessary as-built drawings, prepare all documents and obtain all necessary approvals of governmental departments having jurisdiction over their work. The Contractor shall also be responsible for obtaining all required certificates of inspection for his work and deliver same to the Owner and Owner's Consultants before requesting acceptance and final payment for the work.
- C. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus or drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.

1.5 COORDINATION AND CLARIFICATION

- A. Coordinate with other contractors or subcontractors all work relating to this section.

- B. The Contractor must establish with other contractors or subcontractors, having related work in this section, that all work necessary to complete the pool(s) as shown on the drawings and in the specifications is included in the base bid and alternates to the Owner.
- C. If in doubt regarding the responsibility for work covered in this section and/or discovery of errors or omissions in the bidding documents, the Contractor shall notify the Architect through channels established by the specifications and request a clarification ten (10) days prior to the bid date.

1.6 ALTERNATES

- A. Review the description of the alternates in Division 1 and on the drawings for possible effect upon work in this section. Alternates related to the work in this section are described in this division and on the bid proposal form.
- B. Pool Alternates
 - 1. Alternate #2: Dive Pool – The complete diving pool and all associated diving pool systems, complete and operational as a lump sum additive alternate for the aquatics scope of work. Refer to Architecture for associated pool deck, spectator seating, and site construction to be included in the General Contractor's alternate bid scope.

1.7 CONTRACTOR'S ALTERNATE PROPOSAL

- A. Contractor shall submit his bid to the owner based on materials, equipment and methods as specified in this Section. No substitutions of material will be allowed.
- B. It is the intent of the contract documents to encourage competition. The base proposal must be on providing the construction methods and equipment as specified and detailed. Any proposed system substitution must have prior written approval by the Architect.
- C. If there is any deviation from the basis of design equipment it is the responsibility of the contractor to confirm that all engineering criteria are appropriate for the substituted equipment.
- D. All proposed substitutions of specified construction methods and equipment shall include a complete submittal as required by these specifications and drawings of appropriate scale incorporating all required changes. The Contractor shall provide a list of at least ten (10) satisfactory installations comparable to this project that have been manufactured and installed under the manufacturer's current legal name. Submit a list of such projects with the name, address and current telephone number of the Owner's Operator and Architect of Record to the Architect on the bid date.
- E. Any changes or modifications to the Contract Documents that are not authorized by the architect shall be the sole responsibility of the Contractor.

1.8 SUBMITTALS

- A. All submittals shall be made in accordance with the requirements of Division 1 - General Requirements and in strict compliance with the following procedures and guidelines.
- B. One (1) set of shop drawings and engineering data shall be tabbed, indexed, and referenced to the specifications, compiled into an electronic submittal, and submitted in two stages. The first stage shall include all items for the pool shell(s), reference swimming pool structural specifications. The second stage shall be for all remaining items. Each section of items shall be prefaced by a cover sheet listing the items submitted within the section. All electronic submittals shall be organized,

numbered, and submitted in the same format and order as the project specifications. Only complete sets will be reviewed.

1. Engineering data covering all systems, equipment, structures and fabricated materials, which will become a permanent part of the work under this contract, shall be submitted for review. This data shall include drawings and descriptive information in sufficient detail and scale to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorage and supports required; performance characteristics; fabrication and dimensions needed for installation and correlation with other materials and equipment. A certification, in writing, shall be provided indicating that all equipment will fit in the space allotted and as shown on the drawings.
2. All submittals regardless of origin shall be stamped with the approval of the CONTRACTOR and identified with the name and number of this contract, CONTRACTOR'S name, and references to applicable specification paragraphs and contract drawings. Each submittal shall indicate the intended use of the item in the work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.
3. The submittals will not be accepted from anyone but the CONTRACTOR. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.
4. The CONTRACTOR'S stamp of approval is a representation that the CONTRACTOR accepts full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data, and that he has reviewed or coordinated each submittal with the requirements of the work and the contract documents.
5. Each submittal shall include a statement prepared by the originator of the drawings and data, certifying compliance with the contract documents except for deviations, which are specifically identified.
6. All deviations from the contract documents shall be identified on each submittal and shall be tabulated in the CONTRACTOR'S letter of transmittal. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by the CONTRACTOR (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.
7. The CONTRACTOR shall accept full responsibility for the completeness of each submission, and, in the case of a resubmission, shall verify that all exceptions previously noted have been taken into account. In the event that more than one resubmission is required because of failure of CONTRACTOR to respond to exceptions and rejections previously noted, CONTRACTOR shall make all further resubmissions in person at the consultant's office.
8. Any need for more than one resubmission, or any other delay in obtaining review of submittals, will not entitle the CONTRACTOR to an extension of the contract time unless delay of the work is directly caused by a change in the work authorized by a change order.
9. Review of drawings and data submitted by CONTRACTOR will cover only general conformity to the drawings and specifications, external connections and dimensions that affect the layout. Review does not indicate a thorough review of all dimensions, quantities, and details of the material, equipment, device or item shown. Review of submittals shall not relieve CONTRACTOR from responsibility for errors, omissions, or deviations, or responsibility for compliance with the contract documents.

10. When the drawings and data are returned marked REJECTED, REVISE AND RESUBMIT or SUBMIT SPECIFIED ITEM, the corrections shall be made as noted thereon and as instructed and six corrected copies (or one copy and one corrected reproducible copy) resubmitted.
11. Resubmittals shall bear the number of the first submittal followed by a letter (A, B, etc.) to indicate the sequence of the resubmittal. All resubmittals shall be indexed, tabbed, referenced to the specifications and bound in a three-ring binder and submitted at one time.
12. When corrected copies are resubmitted, the CONTRACTOR shall, in writing, direct specific attention to all revisions and shall list separately any revisions made other than those called for on previous submissions.
13. When the drawings and data are returned marked NO EXCEPTIONS TAKEN or MAKE CORRECTIONS NOTED, no additional copies need to be furnished unless specifically requested to do so for record.

C. Permits, Receipts and Test Reports

1. Provide the Architect with copies of all permits and receipts for fee payments.
2. Submit a sample format for each test report intended for use. Submit test reports required herein only on approved forms.

D. Include complete product data indexed, tabbed, and referenced to specifications with 8 ½" x 11" cover sheet covering:

1. Paragraph 2.1 - Overflow System
2. Paragraph 2.2 - Pumping Equipment
3. Paragraph 2.3 - Filtration Equipment
4. Paragraph 2.4 - Recirculation Fittings
5. Paragraph 2.5 - Piping Systems
6. Paragraph 2.6 - Chemical Treatment Systems
7. Paragraph 2.7 - Chemistry Monitoring and Control Systems
8. Paragraph 2.8 - Flow Meters
9. Paragraph 2.9 - Water Level Controllers
10. Paragraph 2.10 - Inserts and Anchor Sockets
11. Paragraph 2.11 - Deck Equipment
12. Paragraph 2.12 - Loose Equipment
13. Paragraph 2.13 - Maintenance Equipment
14. Paragraph 2.14 - Safety Equipment
15. Paragraph 2.15 - Thermometers

- 16.Paragraph 2.16 – Swimming Pool Finishes
- 17.Paragraph 2.17 - Waterproofing
- 18.Paragraph 2.18 – Sealants
- 19.Paragraph 2.19 – Aquatic Facility Management Application
- 20.Paragraph 2.20 - Underwater Lights
- 21.Paragraph 2.21 - Pool Cover
- 22.Paragraph 2.22 – Pool Heaters

E. Include engineering/construction drawings for the pool structure.

- 1. Reference Division 3 - Concrete.

F. Include engineering construction drawings for all pool piping.

G. Reference Section 131104 – Swimming Pool Cementitious Finish

H. Reference Section 131103 – Swimming Pool Tile

I. Reference Section 131106 – Swimming Pool Timing System

1.9 OPERATION AND MAINTENANCE MANUALS AND CLOSE-OUT SUBMITTALS

A. Detailed operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The equipment supplier and/or CONTRACTOR shall prepare an operation and maintenance manual for all equipment. Parts lists and operating and maintenance instructions shall be provided.

B. Each operation and maintenance manual shall include the following:

- 1. Equipment function and calibration, normal operating characteristics, and limiting conditions.
- 2. Assembly, installation, alignment, adjustment and checking instructions.
- 3. Operating instructions for start up, routine and normal operation, regulation and control, shut down and emergency conditions.
- 4. One (1) copy of all instructional videos.
- 5. Operating cycles shall be specifically described in outline format and in referenced detail. A wall-mounted color-coded piping flow diagram shall be provided in the pool equipment room. The diagram shall be engraved on laminated plastic with color-coded piping to match color of coding on piping, and including valves identified with number on tags. The minimum size shall be 11 inch x 17 inch.
- 6. Include manufacturer recommended maintenance schedule, parts lists, piping diagram (to agree with wall mounted diagram) and trouble-shooting information for all pool mechanical equipment.

7. Using reference to keyed valves and wall diagram, include specific written instructions for procedures to be followed for the following:
 - a. Emptying and refilling the pool(s) including de-watering during the period that the pool(s) will be empty;
 - b. Water level control adjustment and chemical control operation;
 - c. Normal surge tank operation and balancing;
 - d. Filter operation and backwashing; and
 - e. Super chlorination.
8. Lubrication and maintenance instructions.
9. Guide to "trouble-shooting".
10. Parts list and predicted life of parts subject to wear.
11. Outline, cross section, and assembly drawings; engineering data and wiring diagrams.
12. Test data and performance curves, where applicable.
13. Specific written instructions for procedure for emptying and refilling the pool(s) including de-watering during any period that the pool will be empty. Include furnishing and installing a yellow warning sign 8-1/2 in. x 11 in., to be mounted in the filter room, that reads:

WARNING
Prior to emptying Pool
Consult O & M Manuals for Procedures

Add another sign shall read:

Keep all Caps, Plugs and Tops Tight Fitting to Prevent Escape of Fumes.

14. One set of applicable submittals shall be included in each manual.
- C. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by the CONTRACTOR.
 - D. Manuals and other data shall be printed on heavy, first quality paper, 8-1/2 x 11 inch size with standard 3-hole punching and inserted in plastic covers. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches. Where reduction is not practical, larger drawings shall be folded separately and placed in envelopes that are bound into the manuals. Each envelope shall bear suitable identification on the outside.
 - E. Six (6) bound volumes of each manual shall be submitted. All parts lists and information shall be assembled in substantial manuals and permanent, three-ring or three-post binders. Material shall be assembled and bound in the same order as specified, and each volume shall have a table of contents and suitable index tabs.
 - F. All material shall be marked with project identification. Non-applicable information shall be marked out or deleted.

- G. Shipment of equipment will not be considered complete until all required manuals and data have been received.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver material in manufacturer's original, unopened containers and crates with all labels intact and legible.
- B. Deliver materials in sufficient time and quantity to allow continuity of work and compliance with approved construction schedule.
- C. Handle materials in a manner to prevent damage.
- D. Store all materials on clean raised platforms with weather protective coverings. Provide continuous protection of materials against damage or deterioration.
- E. Remove damaged materials from site.

1.11 WARRANTIES

- A. The CONTRACTOR warrants to the Owner and Architect that materials and equipment provided under the contract will be of good quality and new unless otherwise required or permitted by the contract documents, that the work will be free from defects not inherent in the quality required or permitted, and that the work will conform with the requirements of the contract documents. Work not conforming to these requirements, including substitutions not properly approved and authorized will be considered defective. The CONTRACTOR'S warranty will exclude remedies for damage or defect caused by abuse, improper or insufficient maintenance, improper operations, modifications not executed by the CONTRACTOR or improper wear and tear under normal use. If required by the Architect, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment. All warranties shall be for a period of one year from the date of substantial completion or the owner begins using the pool unless otherwise specified.
- B. The CONTRACTOR shall agree to repair or replace any defective or non-complying work at no cost to the Owner upon written notification from the Owner within the warranty period. Pro-rated warranties are not acceptable.
- C. Submit all warranties covering, but not limited to the following:
 - 1. All pool deck equipment and accessories against defects in material, manufacturer and installation for a period of one (1) year.
 - 2. Defects in material, manufacture or installation of the recirculating overflow system and interior coating of the trench for a period of one (1) year.
 - 3. Defects in material, manufacture and installation of the filtration, backwash, chlorination, pH adjustments and cleaning systems, including controls for a period of one (1) year.
 - 4. Defects in material or workmanship of the pool structure causing a loss of water for a period of three (3) years.
 - 5. Defects in material, workmanship, and installation of the pool piping system for a period of three (3) years.
 - 6. Defects in material, workmanship, and installation of the pool pumps for a period of one (1) year.

7. Manufacturer's minimum five (5) year warranty against defective materials, components and workmanship in the pool chemical controller. ORP, pH, flow and temperature sensors shall be covered by a standard two (2) year warranty. All other sensors and flow cell components shall be covered by a standard one (1) year warranty.
8. Manufacturer's minimum eighteen (18) month warranty against defective materials, components and workmanship in the Variable Frequency Drive system effective the date of supply
9. Defects in material, workmanship, and installation of the pool cementitious finish against cracking and delamination for a period of three (3) years.
10. Defects in material, workmanship, and installation of the tile finish against cracking and delamination for a period of five (5) years.
11. Manufacturer's minimum fifteen (15) year warranty on the filter tank against defective materials or workmanship of the tank and components. (Additional warranty time may be purchased from the manufacturer.) Prorated warranties are not acceptable.
12. Manufacturer's minimum one (1) year warranty against defective materials, components and workmanship in the sanitizing feed system.
13. Manufacturer's minimum one (1) year warranty against defective materials, components and workmanship in the pH buffer feed system.
14. Manufacturer's minimum fifteen (15) year systems warranty against defective materials, components and workmanship in the pool tile setting materials.
15. Manufacturer's minimum five (5) year warranty against defective materials, components and workmanship in the pool cover system and reels.
16. Manufacturer's minimum one (1) year warranty against defective materials, components and workmanship in the ultraviolet sanitizing system (excluding the UV arc tube). UV arc tubes are warranted to operate for 4000 hours when operated continuously. A continuously operated UV arc tube that fails prior to 4000 hours of operation shall be replaced free of charge. Intermittently operated UV arc tubes (>1 on/off cycle per day) will be replaced free of charge if failure occur prior to 2000 hours and prorated between 2000 and 4000 hours.

1.12 SYSTEM TRAINING

- A. A qualified representative of the CONTRACTOR performing work under this section shall put the equipment into operation and instruct the Owner's representatives in the operation of this equipment to the Owner's satisfaction immediately after project's substantial completion.
- B. The CONTRACTOR'S training representative shall have completed the equipment/system's manufacturer's training requirements and be certified, by the manufacturer, to provide and teach system training.
- C. The representative from the CONTRACTOR shall be either a CPO (Certified Pool Operator) or have an AFO (Aquatic Facility Operator) certification.
- D. Training periods shall consist of 32 hours of on-site training and scheduled as follows:
 1. 16 hours of initial training on the complete swimming pool system. The 16 hours of initial training is to be comprised of at least 4 hours of training on water chemistry analysis and

adjustment. The water chemistry training will include in depth review of the use of the Langlier index and its computation.

2. The initial 16 hours of training shall include information on the care, operation, adjustment, and maintenance of all items provided by the CONTRACTOR under the "Part 2 – Products" section of this specification.
3. 16 hours of training after the Owner's staff has had experience operating the system. This time may be requested any time after the pool has been placed in operation within a period of one (1) year from the time the pool was accepted by the Owner. The additional training shall contain at least 2 hours of review of water chemistry.
4. The CONTRACTOR shall provide a project specific video recording instruction manual in addition to the training sessions. The video instructions shall be project specific and shall include information on the care, operation, adjustment, and maintenance of all items provided by the CONTRACTOR under the "Part 2 – Products" section of this specification. This video recording shall be done separate from the Owner training.
5. The CONTRACTOR shall include one (1) copy of all video recording instructions in each Operations and Maintenance Manual.

1.13 POOL FILL WATER QUALITY

- A. The Owner shall bear the cost of the water required for two (2) complete fillings of the pool (the initial water tightness test and the final filling). Removal of iron or copper (if in excess of .3 ppm) will be required for the final fill to avoid staining of the pool finish. Any subsequent fillings or partial fillings (more than 25%) of the pool shall be by the CONTRACTOR, at its own expense.
- B. The CONTRACTOR shall provide the necessary plant equipment so that the temperature of fill water will be within plus or minus 10 degrees of the ambient air and/or the pool structure at the time of filling. Extreme caution is urged if the temperature variance is greater than 10 degree F.
- C. The CONTRACTOR shall provide the necessary chemicals and to adjust and balance the water chemistry in the pools to the following levels:

| | |
|---|-------------------------|
| pH | 7.4 - 7.6 |
| Calcium Hardness | 200 - 400 PPM |
| Total Alkalinity (Calcium Hypochlorite) | 60 - 80 PPM |
| Langelier saturation index | -0.3 - +0.3 |
| Total Dissolved Solids (TDS) | not to exceed 1,500 PPM |

1.14 START-UP CHEMICALS

- A. The CONTRACTOR shall maintain the chemical balance of the pool water (including the cost of all chemicals required) until the pool and mechanical system(s) are fully operational and accepted by the Architect and the Owner.
- B. Provide the Owner with sufficient quantities of the necessary chemicals to maintain the pool operation for a minimum of thirty (30) days from substantial completion or the owner begins using the pool.
- C. Chemicals to be provided to the Owner shall include those required by the chemical feed systems installed.

1.15 RECORD DRAWINGS

- A. Provide a complete set of record drawings of the entire pool system(s) including all sub-systems. All record drawings shall be prepared in accordance with the requirements of Section 017839 and shall be a complete, stand-alone set. The CONTRACTOR shall be permitted to obtain original documents and copy them for this purpose only. Provide the record set on compact disk (AutoCAD Release 2010 or compatible software).

PART 2 - PRODUCTS

2.1 OVERFLOW SYSTEM

- A. It is the intent of the specifications that the perimeter overflow system and surface cleaning be maintained under all conditions of normal operation and that no water be discharged to waste except when cleaning the filters or emptying the pool.
- B. Concrete Perimeter Overflow System
 - 1. A perimeter overflow system consisting of a continuous concrete and tile overflow channel as detailed and shown on the drawings shall be installed on the pool(s). The bottom of the trough shall be level throughout.
 - 2. The complete gutter trough interior shall be coated with epoxy paint. Refer to section 2.16. Areas not meeting the manufacturer's recommended thickness will be recoated without additional cost to the Owner.
 - 3. All grating corner installations shall be prefabricated thermo-welded corner sections provided by the grating manufacturer and installed with adequate support per manufacturer recommendations. Butting grating sections together at corners shall not be permitted.
 - 4. The grating shall be formed of molded PVC sections. Modular, interlocking pieces of UV stabilized PVC grating. The top surface shall have a raised, diamond ridge design to create good friction, wet or dry and be 11/16" wide with an outside depth of 1.0" and a middle depth of 1-3/8" for extra strength. The space between pieces shall not exceed 3/8". Each piece of grate shall have a slotted hole at the ends for insertion of a stainless steel fastener clip and anchor screws every 5 feet and shall be easily removable. Grating surface bars shall run parallel to the pool wall and with the gap, provide at least 35% open space per foot for unrestricted water flow. The color of the grate shall be selected by the Architect. The width of the grating shall allow the insertion of the touchpad holding brackets between the grating and the gutter lip.
 - a. Basis of Design: Grating shall be manufactured by Lawson Aquatics supplied by Neptune-Benson, Daldorado, or approved equal.
 - 5. All materials, anchors and fasteners shall be 304L stainless steel.

2.2 PUMPING EQUIPMENT

- A. Any proposed substitutions shall include a mechanical drawing incorporating all required changes in layout, piping and valves. The cost of such changes shall be included in the price of the substitute. CONTRACTOR to confirm voltage prior to ordering pump. All motors shall be capable of continuously running without overloading at any point on the characteristic curve of the pump without overload or harm. CONTRACTOR shall confirm by 1/4 inch scale shop drawing that the pumps and filters to be provided will fit in the available space and can be removed for servicing.
 - 1. Pumps shall be certified by the National Sanitation Foundation (NSF) and bear the certification mark.

2. Pump casing shall be cast iron fitted with a replaceable bronze case wear ring. Mechanical seals shall be provided specific for a clear, mildly chlorinated water application. Pump impeller shall be enclosed type of cast bronze, statically and dynamically balanced, and trimmed for the specified design conditions. If a VFD is to be used in conjunction with a pump, the impeller shall be trimmed to the maximum diameter based on the rated motor horse power. All bronze materials shall be suitable for use in a chlorinated environment. Suction and discharge flanges shall be provided and tapped for gauge connections. Provide steel or cast iron bases.
3. If the pump is powered with a VFD, the impeller to be trimmed to a maximum diameter based on the most limiting condition of either the diameter of the maximum non-overloading rated motor horse power at the design point or a diameter resulting in 10% greater head than the specified head.
4. Pump motor shall be totally enclosed, fan cooled (TEFC) and premium efficiency of the horsepower and speed specified. A pump requiring larger horsepower shall not be acceptable.
5. Provide a hair and lint strainer, for each pump, of fiberglass or epoxy coated stainless steel construction with a clear observation top in the sizes (or pipe sizes) indicated on the drawings. Verify and coordinate pipe and pump suction sizes in the field. Strainer to be of a low pressure drop full-open or a tapered eccentric reducing type. Straight reducing type strainers will not be acceptable without the addition of an approved tapered eccentric reducer between the strainer and the pump (in which case, sufficient space in the pump pit must be verified). Provide a stainless steel basket with at least 4 times the free open area as the inlet pipe, and one spare basket with each strainer.
 - a. Basis of Design: As manufactured by MerMade Filter Inc., or Neptune/Benson Inc., or Fluidtrol Process Technologies, Inc.
6. Provide a fusion-bonded epoxy coating on all wetted parts to protect pump internals from corrosion, including pump volute interior and complete pump impeller. Sandblast to bare, white metal. Thickness shall be 8 to 12 mils (heavy film). Verify thickness by non-destructive testing. Coat parts as recommended by manufacturer, including preheating parts to 400 degrees and electrostatic deposition or fluidized bed technique. Provide primers if required to resist chlorinated water <10 ppm. Coating shall be Scotchkote 134 manufactured by Fusecote or approved equal.
7. Entire pumping unit shall be mounted on a base using cap screws to preserve the back pull-out feature of the pump. Pumps shall not be secured with floor studs. The pump base shall be coated with the same epoxy coating as the pump. An OSHA approved guard shall protect coupling and exposed rotating components of the pump and motor where required.
8. Recirculating Pumps and Motors
 - a. Competition Pool
 - 1) Provide one (1) horizontally mounted centrifugal pump, as shown on the drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 1,100 GPM against 72 ft. TDH with an efficiency of no less than 80% and a required net positive suction head (NPSHr) no greater than 15 ft. It shall be provided with a 30 HP, 1780 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications.
 - a) Basis of Design: The system design is based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered, provided they meet the requirements.

b. Training Pool

- 1) Provide one (1) horizontally mounted centrifugal pump, as shown on the drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 300 GPM against 77 ft. TDH with an efficiency of no less than 76% and a required net positive suction head (NPSHr) no greater than 15 ft. It shall be provided with a 10 HP, 1775 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications.
 - a) Basis of Design: The system design is based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered, provided they meet the requirements.

c. Dive Pool (Alternate #2)

- 1) Provide one (1) horizontally mounted centrifugal pump, as shown on the drawings and described in these specifications. Each pump is to be of a straight centrifugal, end suction, bronze fitted, close coupled type, capable of pumping 475 GPM against 71 ft. TDH with an efficiency of no less than 81% and a required net positive suction head (NPSHr) no greater than 15 ft. It shall be provided with a 15 HP, 1775 RPM, 460 VAC, 3 phase, 60 cycle electrically driven motor meeting these specifications.
 - a) Basis of Design: The system design is based upon Paco. Pumps manufactured by ITT Marlow, Griswold, or Aurora shall all be considered, provided they meet the requirements.

- d. All recirculation pumps shall be provided by the same manufacturer. Confirm voltages prior to ordering pumps.

9. Other System Pumps and Motors

- a. Provide one (1) portable utility pump(s). The pump(s) shall be a 1 HP, 3600 RPM, 115/230 volt, 1 phase, 60 cycle unit capable of 60 GPM at 25 ft. TDH.
 - 1) Basis of Design: Pump to be a Godwin GSP10 or approved equal.

B. Variable Frequency Drive Starters

1. Provide VFD starters for all pool pumps. VFDs shall be a product of H2Flow Controls, Pentair AcuDrive, Neptune Benson, or approved equal.
 - a. Basis of Design: Eco-Flo-C by H2 Flow Controls.
2. It is the contractor's responsibility to ensure that all equipment is provided with the correct operating voltage and that all interconnected electrical and electronic equipment shall adequately communicate and operate the specified pumping equipment. All equipment installations shall meet or exceed the requirements of the National Electric Code and all other local and state regulations.
3. Specified equipment in this section shall be mounted in accordance with manufacturer's requirements and in a suitable location where indicated on the plans or approved by the Architect/Engineer. All electronic equipment installed where a corrosive atmosphere may exist shall be enclosed in NEMA 4 stainless steel or NEMA 4X nonmetallic enclosures. In other locations NEMA 12 enclosures are acceptable. The programmable and display features of all electronic equipment shall be accomplished via NEMA 4X enclosed key pads and operator backlit LCD Graphical/Alpha/Numerical Displays. VFD's installed within a supplementary panel

shall not be vented or cooled from ambient external air. With the exception of the VFD's heatsink and water-resistant heatsink fan, the VFD's electronics shall be fully sealed within the NEMA 12 or higher enclosure. So called 'NEMA 12 or NEMA 4 Vented' enclosures are not permitted.

4. The VFD shall convert incoming fixed frequency three phase AC power into a variable voltage and variable frequency three phase output utilizing pulse width modulation. Advanced Space Vector Control will be utilized to reduce motor heating and provide precise control of the AC motor.
5. The VFD shall be capable of adjusting the pump motor speed based upon specific flow requirements. A 4-20 milliamp output signal from a Programmable Aquatic Controller, PLC, electronic flow meter transmitter or other electronic device shall supply the required flow information to the VFD to regulate motor speed. The VFD shall be capable of interfacing to this analog output signal be commissioned to achieve a 'constant flow' condition. The VFD shall also be provided with a manually operated potentiometer to adjust the pump speed in the case of an electronic communication failure.
6. Electronic equipment shall be supplied with a phase rotational check capability. The contractor shall also be required to assure that a phase rotational check is accomplished with the bypass switch, herein specified, in the across the line position to assure correct rotation when connected to all motor power sources.
7. The VFD shall include a built-in Line Filter to mitigate harmonic distortions being transmitted back through the supply lines.
8. The VFD shall utilize DC link reactors to filter out bus ripple and provide smooth DC power to the transistor section.
9. The VFD shall utilize IGBT transistors to produce a pulse width modulated output. SCR output stages are not acceptable.
10. The VFD shall have a full load amp rating which exceeds or meets NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, and shall be able to provide 110% of its variable torque rating and 150% of its constant torque rating for one minute.
11. The VFD shall utilize space vector control to reduce motor harmonics and torque ripple.
12. The VFD shall include the ability to reliably protect the pump from any of the following abnormal pump conditions: Run Dry/Loss of Prime; Cavitation; Dead head/Closed Valve; Worn impeller; Blocked Filter; Bearing Failure/Wear Detection. Protection using measured current (Amps), as a method for these protective features shall not be acceptable.
13. The VFD shall provide a display with selectable readout of parameters, including: Speed; Torque; Electrical Power; Current; Output Voltage; Frequency; Heatsink Temperature; Motor Temperature; Run Time; Energy Consumed; Mains Time.
14. The VFD shall include the capability for copying of settings when multiple similar pumps are involved. Settings established in one VFD shall be transferred to the others via a removable keypad.
15. All VFDs shall be provided with a bypass function to allow for pump motor operation by bypassing the variable frequency drive. Bypass mechanism may be internal to the VFD cabinet or provided in a separate enclosure with NEMA rating equivalent to the specified drive enclosure. NEMA 12 'vented' panels are not acceptable. The bypass shall be UL listed as a motor disconnect device.

16. Three Motor Contactors shall be included. Contactor A is required to be in series with the Line Power supply and the VFD, Contactor C is required to be in series with the VFD and the motor and Contactor B is required to bypass the VFD. In 'VFD' operation, contactors A and C are engaged and contactor B is open. When in 'Bypass' mode, contactors A and C are open and contactor B is engaged.
 - a. All contactors shall be appropriately rated for the supply voltage and pump motor specified and shall be in accordance with NEC standards.
 - b. Contactor B shall include an appropriately rated Motor Overload.
 - c. Resettable pump motor overload protection shall be provided for both the VFD and across the line sources of power to all motors.
17. A Control Power Transformer shall be included so as to provide the necessary control voltage required to operate the Motor Contactors. The VFD panel or separate Bypass panel, shall include a door mounted 3-position lockable selector switch. The switch shall be labeled: VFD-OFF-BYPASS. The switch is to require a key to move from one position to another. Two keys shall be provided to the customer. The Bypass panel shall be manufactured in accordance with and approved to UL508.
18. All applications shall require the inclusion of an appropriately rated Line Reactor to reduce harmonic distortion. The Line Reactor shall be housed in an enclosure according to the manufacturer's instructions, taking careful note of the device radiated heat and the chemical environment in which it may be installed. Pentair Acu-Drive includes as standard a built in DC Link Reactor (equivalent to 5% Line Reactor). Where this is insufficient, a separate larger Line Reactor shall be provided.
19. All applications that will have a cable length between the VFD and the Pump Motor which exceeds 300 feet shall require the inclusion of an appropriately rated Motor Protection Filter (dV/dt filter). When included, the Motor Protection Filter shall be housed in an enclosure according to the manufacturer's instructions, taking careful note of the device radiated heat and the chemical environment in which it may be installed.
20. The VFD shall include additional contacts for interface with a remote start/stop panel and/or emergency stop function. When the VFD is supplied for a spa hydrotherapy pump, the drive shall also interface with a remote timer switch to control pump operation via a preset timed duration (15 minute timer switch).
21. Installations in locations where a Power Disconnect is not within 'line of sight' of the VFD Control Panel, or where deemed necessary by local electrical codes, shall require the installer to provide a suitably rated Circuit Breaker Disconnect.
22. The VFD shall be UL listed to accept a supply voltage of -15% / + 10% of its stated supply rating.
23. The VFD shall be electronically lockable in order to prevent unauthorized or unintended program changes.
24. Motors to which the VFD is to be installed shall have a minimum insulation of "Class F".
25. User Interface for initial programming and day to day operation.
 - a. The VFD shall include a programmable Controller with an operator backlit LCD Graphical / Alpha / Numerical Display. The Controller shall comprise the following features:

- b. Real Time Clock
 - c. Password protection
 - d. Hard-wired tamper protection feature
 - e. Custom software to control the VFD via a Modbus communication network.
 - f. Automatic Flow Control. The Controller and VFD are to automatically adjust the pump's speed in order to compensate for a filter becoming dirty. The system is to maintain a minimum flow (GPM) required to meet State mandated turnover rates.
 - g. Programmable speeds for daytime and nighttime turnover rates.
 - h. Non-volatile memory. All programmed parameters as well as the real time clock settings shall be maintained in the event of a power outage.
 - i. The Controller shall be capable of interfacing to an analog output signal from a Flow Transducer and displaying measured flow in GPM
 - j. Automatic reset of alarms caused by power brown outs/power loss
 - k. External input for seasonal/unoccupied speed
26. Equipment specified in this section shall be programmed and tested under power after connection to the required motor by a factory trained technician. All low voltage control wiring connections to the respective pool systems shall be provided by the Swimming Pool Contractor. Line voltage and/or high voltage connections and interlocks shall be provided by the Electrical Contractor.

C. Pump Gauges

- 1. Pressure gauges shall be installed on the discharge of the pumps.
- 2. Compound gauges shall be provided at the intake port of the pumps, after the hair and lint strainer.
- 3. Gauges shall be liquid filled, 316L stainless steel bourdon tube type with a minimum 2-1/2 inch diameter dial, high impact polypropylene or stainless steel case, corrosion resistant white scale with black divisions and numerals, 300 Series stainless steel heavy duty rotary bushed movement, , black enameled balanced Micrometer pointer.
 - a. Basis of Design: Gauges shall be as manufactured by Weksler Instrument Corporation or approved equal.
- 4. Scale ranges shall be selected to indicate the normal system operating pressure of each system or location within the system. Pressure ranges shall be calibrated in psig (0-60 psi) and compound gauge shall be calibrated in inches of mercury (0-30 in Hg / 0-60 psi).
- 5. A stainless steel filter type pressure snubber shall be provided for each pressure gauge installed consisting of a 3/8 inch diameter by 1/8 inch thick micro metallic stainless steel filter and placed in the line just before the pressure gauge. Provide isolation brass valves or brass gauge cocks at each gauge for easy replacement and maintenance.

- D. Provide link seals for all pipe penetrations as indicated on the drawings. Locations will include the surge tank, the pump pit, foundation wall penetrations (*if expansive soils are present*) and other locations as noted. Link seals shall be provided in the sizes and quantities shown on the drawings and installed to provide a flexible watertight penetration. Metal parts shall be made of 316L stainless steel. Links shall form a continuous rubber seal that is tightened with a series of stainless steel bolts to form a watertight seal. Link seals shall be manufactured by Thunderline Corporation, Calpico Inc. or approved equal. Xypex Patch'n Plug or approved equal shall be used to seal pipe penetration. The CONTRACTOR is to provide factory plastic wall sleeves of the appropriate sizes designed for the specific application and seal size and type. Each sleeve is to have an integrated water stop.

2.3 FILTRATION EQUIPMENT

- A. The filter system shall consist of high rate pressure sand filter tanks as shown on the drawings. Every aspect and component of the filter system must be certified by the National Sanitation Foundation (NSF) and bear the certification mark. The filter must have an engraved metal data plate permanently affixed on the face of the system that describes operational data and instructions and indicates start up date.
- B. It is the intent of these specifications to describe a filtration system complete in every respect with all accessory items and supplied and warranted by one manufacturer.
- C. Horizontally Oriented Fiberglass Tanks
1. The filter tanks shall be horizontally oriented single cell fiberglass tanks, minimum 42 inches in diameter. The filter system must be listed as approved by National Sanitation Foundation prior to bid date.
 - a. Basis of Design: Fiberglass filters shall be the product of Paragon Aquatics / Stark, Waterco, or Neptune Benson provided they meet the specifications and layout. System design based upon Neptune Benson. Valves must be provided to backwash one filter at a time.
 2. Filter tanks must incorporate all components and feature as described in this section.
 3. Two (2) saddle style bases shall be provided for tank support. Systems that incorporate stacked tanks shall include similar bases and mounting saddles for the upper vessel. Tank supports and connections shall be seismic rated to support the filter tank(s) for the appropriate seismic zone where the project is located. Access to the tank shall be provided by a 14" x 18" manhole with two (2) curved yokes. Manhole seal shall be complete with a one piece 1/4" neoprene gasket and positioned so that internal pressure from the filter will augment the seal. No additional hardware or through bolts will be allowed.
 4. Each filter tank shall be equipped with the necessary flanges and connections for the internal and external piping. Connections shall be comprised of fiberglass flanges and schedule 80 PVC flanges.
 5. All tank connections 2 inches and smaller shall be 150 lb. Type 316L stainless steel threaded full couplings. All tank connections 3 inches and larger shall be heavy steel bosses drilled and tapped both sides to receive standard flanged fittings or Sch. 40 Type 316L stainless steel nipples.
 6. The discharge from the automatic air release valve shall be hard piped to waste. Each filter tank shall have a means of releasing air. Each coupling or orifice is to be provided with a slotted PVC sand retainer or stainless steel strainer. An automatic air release system shall be provided for each tank.

7. The drain system shall consist of a 3/4 inch 316L stainless steel coupling mounted at the lowest point in the bottom head. This drain shall be valved and piped to the nearest floor drain or backwash pit.

D. Filter Piping - Internal

1. The lower internal distribution system shall be a horizontal header/lateral arrangement. The header shall be Schedule 80 PVC construction, capped on one end and flanged or threaded at the other end for field connection. Lateral connections shall be spaced no more than 6 inches on centers, and shall be 1-1/2 inch FPT connections. All attachments to header shall be solvent welded and thermo-welded to insure integrity of connection.
2. Under drain system shall be factory installed and constructed of extra heavy Schedule 80 high impact PVC. Multiple PVC main headers to be tapped and threaded to receive laterals.
3. Laterals shall consist of 1-1/2 inch Schedule 80 PVC pipe with openings as required. Each lateral shall be fabricated complete with socket cap on one end and male adapter on the other end. Both fittings to be solvent welded to the slotted pipe. Laterals shall be designed and sized at the factory so as to be installed in the field and over the entire cross sections area of the filter.
4. The upper distributor shall consist of PVC piping Schedule 80 and/or deflector plate per manufacturer standard design.
5. Each filter shall be supplied with a pressure equalizing upper internal distribution system consisting of a horizontal header/lateral arrangement. The header piping shall be constructed of Schedule 80 PVC. The header/lateral piping and all connections shall be designed and sized to provide uniform distribution and unrestricted flow during the filtration and backwash cycles.
6. Upper laterals shall be constructed of Schedule 80 PVC pipe with machine slotted openings or orifices. All machined slots or orifices shall be clean, de-burred and free of any obstructions that would not permit the free flow of water through the opening. Details of the lateral attachment to the header shall be submitted for review and approval.
7. The lower and upper distribution systems shall be properly supported and anchored. All hardware in wetted areas shall be Type 316L stainless steel or non-metallic. Tank interiors must be inspected prior to the media being placed in the filters.

E. Filter Piping - External (Face)

1. External face piping shall be Schedule 80 PVC pipe and fittings. Flanges shall be located so as to allow for easy dismantling of face piping. All fittings shall be solvent cemented.
2. Piping shall be drilled and tapped where necessary to accommodate gauge tubing connectors.
3. All valves 3" and larger shall be constructed with cast aluminum S12A alloy (as defined by ASTM B275) housing and fully coated with Rilsan on all interior and exterior surfaces. Internal components include EPDM resilient lining, Rilsan coated ductile iron disc and 316L stainless steel shaft. Valves shall be rated for 150 psi bubble tight shutoff. Unless otherwise specified, all nuts and bolts shall be stainless steel with stainless steel washers to be used when secured to PVC flanges. Systems incorporating solenoid, pneumatic, pressure amplified, hydraulic or multi-directional valves shall not be acceptable.

4. Standard accessory items shall include sight glass rated for 50 psi with polycarbonate glass, remote mounted gauge panel with two 4½" diameter pressure gauges, ¼" petcocks, ¼" poly vent tubing with PVC compression adapters.

F. Backwash Control

1. The filter manifold face piping shall be designed to allow for one (1) filter tank to be backwashed at a time while the recirculation system is operating. A manual backwashing system shall be provided with the filter system.
2. Manual Backwash System
 - a. The manual backwash system shall be equipped with a face piping configuration such that the operator shall be manually control and operator both the time and sequencing of the backwash cycle. Valving on the filter face piping shall be a mechanical linkage device allowing the operator to simultaneously move two (2) valves at once. All mechanical linkage components shall be PVC or Type 316L Stainless Steel.

G. Automatic Air Relief Valve

1. A 1" valve shall be provided to automatically and continuously release air in the filter. The valve shall be fabricated of plastic with Buna-N seals. A plumbing kit shall be provided with two (2) PVC ball valves to allow manual air relief and isolation of the automatic valve. Valves fabricated of cast iron, bronze or stainless steel valves will not be accepted.

H. Filter Media

1. Filter media shall be a carefully selected grade of hard uniformly graded silica material. Media shall be milled angular shaped particles of silica quartz. The filter sand shall have a particle size between 0.45 mm and 0.55 mm and have a uniformity coefficient not to exceed 1.53. Specific gravity shall not be less than 2.5 with a pH of 7.0.
2. All media (sand) shall be cleaned and free from any clay or limestone deposits. Bottom layer of support media shall be placed by hand to avoid damage to the under drain system and leveled before the addition of the upper layer of filter media.
3. All media shall be delivered after approval by the manufacturer of the filter and stored in 100 pound bags for ease of handling and elimination of possible contamination.
4. Media to be supplied by the filter manufacturer and approved by the filter manufacturer prior to shipping.

I. Filter Size

1. Filters have been sized based on a maximum allowable filtration rate of 12 GPM/SF:

| | Units | Competition Pool | Training Pool | Dive Pool (Alt 2) |
|-----------------|------------|------------------|---------------|----------------------|
| Volume | Gallons | 328,511 | 53,388 | 137,502 |
| Flow Rate | GPM | 1,100 | 300 | 475 |
| Filter Model | SHFFG | (4) 42-72 | 42-72 | (2) 42-60 |
| Filter Size | Sq. Ft. | 23.90 ea. | 23.90 | 20.40 ea. |
| Turnover Rate | Hours | 4.98 | 2.97 | 4.82 |
| Filtration Rate | GPM/Sq.Ft. | 11.51 | 12.55 | 11.64 |

2.4 RECIRCULATION FITTINGS

- A. Main outlets (main drains) shall be concrete sumps with 12 gauge PVC frame and PVC gratingl or PVC/Fiberglass box with PVC grating and sized as shown on the plan. Grate openings shall not exceed 11/32 inch in width, providing an open flow area to allow water velocity not to exceed 1.0 fps. The grate shall be PVC and fit closely and flush with top surface of frame, and secured to frame with vandal proof fasteners. All exposed edges of main outlets shall be rounded and smooth, free of burrs and sharp edges. All main drain covers shall comply with the Virginia Graeme Baker Act and ANSI/APSP-16 2011.
- B. Provide hydrostatic relief valves consisting of a 2" cycolac relief valve connected to a FPT commercial style Schedule 80 PVC collector tube. The collection tube shall have seepage holes, 3/8 inch in diameter, and shall be screwed securely to the valve body. The hydrostatic relief valve shall be designed to seal with minimum pressure and shall have a non-plugging, self-cleaning raised valve seat. Hydrostatic relief valve to be Hayward Number SP1056 with collector tube model Hayward Number SP1055, or approved equal.
- C. Concrete drop out boxes (converters) shall be concrete sumps with 12 gauge 316L stainless steel frame and PVC grating and sized as shown on the plans. Grate openings shall not exceed 11/32 inch in width, providing an open flow area to allow water velocity not to exceed 1.0 fps. The grate shall be PVC and fit closely and flush with top surface of frame, and secured to frame with vandal proof fasteners. Provide no-leak seal flange at the midpoint of the boxes.
- D. Wall inlet fittings shall be Hayward Model SP-1421-E (1 inch opening) cycolac directional inlet mounted in Hayward Model SP-1022S or approved equal from Paddock, Sta-Rite, or Swimtime.
- E. Adjustable floor inlet fittings shall be provided each consisting of an ABS plastic body and adjusting top plate with a positive locking device. A spanner wrench shall be provided to facilitate flow adjustment. The inlet body shall be provided with a 2-inch cycolac solvent weld connection and internal NPT threads to facilitate line pressure testing. Floor inlet fittings shall be Sta-Rite No. 8417-0000-White/Sta-Rite No. 8417-0100-Gray/Sta-Rite No. 8417-0200-Black or approved equal.
- F. Sight sump frame and cover shall be 15" x 17" CDR style Quazite polymer concrete enclosure model number B10151712G, with cover model number C10151702A. Cover shall be provided with stainless steel vandal-resistant fasteners. Quazite cover color shall be selected by Architect – standard color is concrete grey.
- G. Water surface agitators shall be as detailed on the plans and connected to the PP3 filtered water supply piping. Construction shall be machined or cast bronze/brass. Face plates shall be removable for alignment or cleaning by using security key part #WMF082. The water inlet connection shall be 1". The unit shall be the Combination Jet (WMD104) for vertical surface mount, by Crystal Fountains (905) 660-6674.
- H. Anti-vortex plates shall be provided at the suction points of the main recirculation pump(s) in the surge tank(s). Each plate shall be connected to the suction pipe via a PVC flange and shall be ½ in. thick with minimum dimension of at least 2.5 times the connecting pipe diameter. The plate shall be located 4 inches above the finished floor of the surge tank. Four (4) 3/4 in. stainless steel threaded rods, nuts, anchor bolts and washers shall be used to fix the offset distance and provide a secure base for the suction pipe. Manufactured fiberglass or PVC anti-vortex plates by Daldorado, Neptune-Benson, or approved equal, shall also be acceptable.

2.5 PIPING SYSTEMS

- A. General

1. Provide all recirculating piping between the pool(s) and the filter room, fill receptor and all interconnecting piping to and from the chemical feed systems and chemical controller.
2. Provide all necessary pipe supports and support systems required to support all associated piping and valves.
3. Provide all other tubing, conduit, or piping associated with equipment specified herein. Coordinate with other trades.

B. Pipes

1. Pipe routing as shown and detailed on the contract drawings is diagrammatic only and is not intended to show minor details or exact locations of piping systems. Installation is required to be adjusted to accommodate interference and adjustments anticipated and encountered. Pipe sizes on plans refer to nominal inside diameter of the pipe.
2. All PVC swimming pool piping shall be NSF approved and conform to the requirements of ASTM D-1785.
3. All PVC pipes shall be the product of one manufacturer. Approved manufacturers of PVC piping are Eslon, Harvel, and Chemtrol or approved equal.
4. Swimming pool piping above the floor or deck in the filter room shall be Schedule 80 PVC.
5. Swimming pool piping below the filter room floor or deck shall be NSF approved, Schedule 80 PVC.
6. All swimming pool piping under the pool floor shall be NSF approved, Schedule 40 PVC and concrete encased. All transitions between Schedule 40 and Schedule 80 shall be encased in concrete.
7. All below grade swimming pool piping not located beneath the pool floor can be backfilled with native granular material free of ice, clay, debris, organic matter, and rocks larger than 4" across their greatest dimension, and per recommendations indicated in the project geotechnical report.
8. The influent and effluent lines to the heat exchanger unit shall be CPVC. Connections between metallic piping and/or equipment and PVC shall be flanged.
9. All PVC and CPVC fittings shall be the product of one manufacturer. Molded fittings shall be as manufactured by Asahi, Eslon, Chemtrol, Harvel, Spear, Lasco or acceptable substitute. Fabricated fittings shall be as manufactured by Harrison Machine, Plastinetics, or acceptable substitute.
10. Vertical sight sump piping shall be NSF approved, Schedule 40 PVC. Horizontal sight sump piping shall be NSF approved, Schedule 40 PVC that is perforated and wrapped with fabric and have 3/8" diameter holes located top and bottom on 4 ft centers. Horizontal sight sump piping shall extend 1 ft minimum beyond the main drain.
11. Chemical feed lines from chemical feeders to recirculation piping shall be Schedule 80 PVC piping. Piping shall be hard piped into the recirculation plumbing. All required valves shall be of all PVC construction.
12. Splash collar(s) for the fill funnel(s) shall be clear Schedule 80 PVC and manufactured from a Type I, Grade I PVC compound with a Cell Classification of 12454 per ASTM D1784. The pipe shall be manufactured in compliance to ASTM D1785.

13. All flanged plumbing connection hardware shall be stainless steel.
14. All materials shall be installed by workmen thoroughly skilled in their trades and all work shall present a neat and mechanical appearance when complete. The CONTRACTOR, at no additional expense to the Owner, shall replace or correct any work not judged acceptable by the Architect, Owner's testing agency, or their consultants.
15. All support hardware, brackets, fasteners, hangers, etc. installed in the surge tank shall be 316L stainless steel.
16. No installation shall be made that will provide a cross-connection or interconnection between a distributing supply for drinking purposes and the swimming pool, or between the pool and a sanitary or storm water sewer system that will permit a backflow of water into the pool water system.
17. All piping shall be hydrostatically (water) pressure tested for leaks before and after backfilling to guarantee water tightness. Pneumatic (air) pressure test not allowed.
18. The CONTRACTOR shall provide 1/4" PVC water stops for this work for watertight penetration of concrete walls. Water stops shall be round and the O.D. shall be sized to 150% of the O.D. of the pipe. The water stops shall be thermo-welded to the pipe from both sides and shall be located at the centerline of the wall being penetrated prior to placing the concrete to assure a watertight seal. Manufactured fiberglass and PVC water stop fittings by Daldorado, A.S.A. Manufacturing, or approved equal shall also be acceptable.
19. CONTRACTOR must adhere to all the applicable provisions in Division 22 - Plumbing, "General Provisions" and "Basic Materials and Methods" for installation of piping system.
20. All mechanical equipment to be connected into the recirculation piping system shall be done so using flanged or union connections.
21. Provisions shall be made to purge all pipes in the system.
22. Concentric reducers shall be fiberglass by MerMade Filter, Inc., or equivalent reducers of schedule 80 PVC construction.

C. Pipe Hangers and Supports

1. Manufacturer
 - a. Subject to compliance with these specifications, pipe hanger and support systems shall be manufactured by Cooper B-line (basis of design), Inc, TOLCO, and Anvil International or approved equal.
2. Hangers
 - a. Pipes 2 inches and smaller
 - 1) Adjustable steel clevis hanger, B-Line models B3100 or B3104.
 - 2) Adjustable steel swivel ring (band type) hanger, B-Line model B3170.
 - b. Pipes 2-1/2 inches and larger
 - 1) Adjustable steel clevis hanger, B-Line model B3100.

- 2) Adjustable steel yoke pipe roll, B-Line model B3114.
 3. Multiple or Trapeze Hangers
 - a. Trapeze hangers shall be constructed from 12 gauge roll formed ASTM A1011 SS, Grade 33 structural steel channel, 1-5/8 by 1-5/8 inch minimum, B-Line B22 strut or stronger as required.
 - b. Mount pipes to trapeze with 2 piece pipe straps sized for outside diameter of pipe, B-Line B-2000 series.
 4. Wall Supports
 - a. Pipes 2-1/2 inches and smaller
 - 1) Steel offset "J" hook hanger, B-Line model B3600.
 - b. Pipes 3 inches and larger
 - 1) Welded strut bracket and pipe straps, B-Line models B3064 and B2000 series.
 - 2) Welded steel bracket B-Line model B3066 or B3067 with roller chair or adjustable steel yoke pipe roll. B-Line model B3120 or B3110.
 5. Floor Supports
 - a. Electroplated carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. B-Line model B3093 and B3088T or B3090 and B8088. Pipe saddle shall be screwed or welded to appropriate base stand.
 6. Vertical Supports
 - a. Steel riser clamp sized to outside diameter of pipe, B-Line model B3373.
 7. Plastic Pipe Supports
 - a. V-Bottom clevis hangers with galvanized 18-gauge continuous support channel, B-Line models B3106 and B3106V, to form a continuous support system for all plastic pipes smaller than 1 inch or flexible tubing.
 - b. A vented and sloped continuous PVC Schedule 40 pipe no smaller than 1-1/2 inch outside diameter will be used to route flexible tubing with the appropriate pipe supports.
 8. Supplementary Structural Supports - Design and fabricate supports using structural quality steel bolted framing materials. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch or greater as required by loading conditions. Submit design for pipe tunnels, pipe galleries etc. for approval. Use clamps and fittings designed for use with the strut system.
- D. Hanger Attachments
1. Upper Attachments
 - a. Beam Clamps

- 1) Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
- 2) C-Clamps shall be locknuts and cup point set screws similar to B-Line model B351L or B3036L. Top flange c-clamps shall be used when attaching a hanger rod to the flange of structural steel, B-Line model B3034 or B3033 or approved equal. Refer to manufacturers recommendations for set screw torque. Retaining straps shall be used to maintain the clamp position on the beam where required.
- 3) Center load beam clamps shall be used where specified. Steel clamps shall be B-Line models B3050 or B3055. Forged steel beam clamps with cross bolt shall be B-Line B3291-B3297 series or approved equal as required to fit beams.

b. Concrete Inserts

- 1) Cast in place spot concrete inserts shall be used applicable, either steel or malleable iron body, B-line B2500 or B3014 or approved equal. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rods sizes, B-line models N2500 or B3014N series.
- 2) Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A1011 Grade 33 structural quality carbon steel, complete with styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs/ft. in concrete, B-Line models B22I, 32I, or 52I or approved equal. Select channel nuts suitable for strut and rod sizes.

E. Hanger Accessories

1. Hanger rods shall be threaded on both ends or continuously threaded rods of circular cross section. Use adjustable lock nuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.

F. Hanger Finish

1. Indoor Finishes
 - a. Hangers shall be zinc plated in accordance with ASTM B633 OR shall have an electro-deposited green epoxy finish.
 - b. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR shall have an electro-deposited green epoxy finish.
 - c. Zinc Plated hardware is not acceptable for use in chemical rooms.

G. Valves

1. Valves 3 inches and larger shall be butterfly type valves, with PVC body, 150# SWP with stainless steel shaft, polypropylene disc and replaceable resilient seat bonded to a rigid shaft and guaranteed for bubble tight shutoff from 27 inch vacuum to 150 PSI. Extended neck 2 inch beyond flanges for any insulated piping shall be provided with handle for manual operation. All valve components shall be suitable for swimming pool chlorinated water service. Butterfly valves shall be Georg Fischer Type 563, Asahi/America Type SP Pool-Pro, Chemtrol Model-B, Simtech VP series, Colonial Valve 411 Series, or approved equal.
2. Valves smaller than 3 inches shall be PVC true union ball valves, full port, three-piece construction, blowout-proof stem, Viton seal with socket end connectors.

3. Modulating float valve in the surge tank(s) shall have PVC body and stainless steel wafer disc. All hardware shall be non-corrodible. The float-operated valves shall be provided horizontally on the main drain lines in the surge tank(s). Valve shall consist of all non-corrosion components including shaft, float arm, pins and floats. Valve shall be suitable for mounting on a 125E class standard PVC flange. The float arm leverage weight and pivot lengths shall be adjustable to obtain desired ratio of surge tank level change to pool gutter overflow level change. Two floats and stabilizer required. Valve shall be Model FV-D XWB (Extra Weight Ball) as manufactured by MerMade Filter, Inc. or approved equal manufactured by EPD, or Fluidtrol Process Technologies, Inc.
 4. Submerged valves up to 3 inches shall be PVC true union ball valves. Submerged valves over 3 inches shall be PVC bodied, wafer type, butterfly valves with stainless steel handle extensions as required. Valves shall be by approved manufacturers listed above. Submerged valves must be provided with all stainless steel connectors. The stem housing extensions shall be properly supported and braced.
 5. All butterfly type valves 8 inches and larger shall be fitted with a water tight gear operator.
 6. All valves located 7 feet or greater off the floor shall be fitted with a chain operator.
 7. All submerged valves, valves buried below grade, or valves not readily accessible, shall be provided with a stainless steel reach rod and handle.
- H. Pipe and valve identification
1. All exposed pool piping shall be equipped with color coded flow directional arrows at thirty (30) inch intervals per local and state swimming pool health code. The Contractor shall verify that all pool piping identification is in accordance with all local and state health regulations.
 2. All valves shall be identified with minimum 1-1/2 inch diameter brass tags stamped with minimum 1/2-inch high numbers and attached to valves with #16 brass jack chain. (Plastic laminate engraved tags with nylon attachment acceptable.) Valves shall be described as to their function and referenced in the operating instruction manual and wall mounted piping diagram to be prepared by the CONTRACTOR.

2.6 CHEMICAL TREATMENT SYSTEMS

- A. Calcium Hypochlorite (Chlorinator Briquettes)
1. Shop drawings complete with a piping diagram depicting the location in which the dry chlorination feeder is to be connected to the system shall be provided and approved prior to installation. Installation of the system shall be as specified in the manufacturer's directions and no exceptions shall be taken.
 2. A factory-authorized representative shall provide training to the owner and the training shall be video recorded per 131100, Section 1.12 of the project contract documents.
 3. Accu-Tab PowerBase
 - a. General Description
 - 1) The system shall be designed to feed low concentrations of calcium hypochlorite in solution intermittently or continuously as required for the pools applications. The system shall be a single pre-assembled, package unit with a welded aluminum frame consisting of chlorinator, electrical box, centrifugal pump, and solution tank for ease of installation and operation. The system shall be the Accu-Tab PowerBase. Only Accu-Tab Blue SI

calcium hypochlorite tablets shall be used, the patented blue colorant added for safety (to help prevent accidental mixing with other chemicals).

- 2) The base proposal requires providing equipment as specified herein, though substitutions will be considered. The bidder is cautioned that substitutions must meet the quality and operational requirements of each feature specified in Section 2 below. Batch systems with pressure mixing components producing chlorine concentrations exceeding the limits of the specifications will not be considered.
 - 3) Any system offered shall use an NSF Standard 50 listed erosion feeder and tablet combination, and shall be capable of meeting all requirements of the Health Department having jurisdiction over the installation.
 - 4) Basis of Design:
 - a) Competition Pool: Model 3140AT
 - b) Training Pool: Model 1030
 - c) Dive Pool (Alternate #2): Model 3070
- b. System Features
- 1) A maximum chlorine solution level of 0.05% (500 ppm) shall be maintained to prevent calcification in system components. Systems producing chlorine concentrations higher than 0.05% shall not be acceptable.
 - 2) Delivery shall be by erosion feed technology to control accurate and consistent concentration limits in the chlorine treatment solution. Soaking type, spray and/or vortex technology systems shall not be acceptable.
 - 3) The chlorinator shall automatically and continuously feed a limited quantity of chlorine in solution as needed; when the system is not running, no more chlorine than that amount which can be fed in one minute or less shall be left in the tank to prevent dilution. Batch systems preparing excess quantities of solution for delivery over an extended period shall not be acceptable.
 - 4) A centrifugal pump wired to the system electrical box shall feed freshly mixed chlorine treatment solution only as required for maximum efficiency. Batch systems requiring the use of a metering pump or pumps to feed pre-prepared standing solution shall not be acceptable.
 - 5) All piping in the chlorinator unit shall be Schedule 40 PVC. Systems with flexible tubing shall not be acceptable.
- c. System Components
- 1) Tablet Chlorinator. Accu-Tab PowerBase chlorinators are designed exclusively for Accu-Tab Blue SI calcium hypochlorite tablets. Tablets are placed on a sieve plate inside the chlorinator; as water flows across the sieve plate, the tablets erode at a rate proportional to the flow rate.
 - 2) Inlet Water Supply Connection.
 - a) Model 1030 - 1" FNPT.

- b) Model 3070AT - 1-1/2" FNPT.
 - c) Model 3140AT - 2" FNPT.
 - 3) Inlet Solenoid Valve. Opens and closes on command when the system receives a signal. 110 VAC required from chemical controller. Applicable to models 3140AT and 3500.
 - 4) Inlet Water Strainer. A strainer to protect chlorinator components from start-up debris and sand from broken filter laterals.
 - 5) Flow Meter. A rotameter flow meter, measuring the flow of the water-eroding stream to the chlorinator.
 - 6) Inlet Control Valve. PVC gate valve mounted in line with the flow meter allows operator to adjust flow of water-dissolving stream. Applicable to models 3140AT.
 - 7) Solution Tank. PowerBase 3500 made of HDPE, all others made of PVC. Capacities:
 - a) Model 1030 7.5 gallon
 - b) Model 3070AT 22 gallon
 - c) Model 3140AT 22 gallon
 - 8) Float Valve. Made from Schedule 80 PVC and 316L stainless steel, this float valve maintains the solution tank level.
 - 9) High Level Switch. Prevents the solution tank from overflowing. High level: when activated, a switch opens the circuit to the solenoid valve, causing the solenoid valve to close. Applicable to models 3140AT.
 - 10) Solution Delivery Pump. Delivers chlorinated solution to the return line. A single-stage centrifugal pump is provided for systems with pressures up to 20 PSIG. (For systems requiring a discharge pressures greater than 20 PSIG, a custom selected pump shall be utilized.)
 - 11) Discharge Check Valve. A PVC swing check valve prevents reverse flow of water into the system.
 - 12) Discharge Control Valve (manual). Used to balance system output water flow with system input water flow.
 - 13) Outlet Connection
 - a) Model 1030 1" NPT
 - b) Model 3070AT 1.5" NPT
 - c) Model 3140AT 2" NPT
 - 14) Aluminum Frame. Type 6061-T.
 - 15) Nema 4X Electrical Enclosure
- d. Optional Equipment

- 1) High Pressure Pump. On systems requiring unit discharge pressures greater than 20 PSIG.
- 2) High-High-Low (HHL) Level Switch. A second high level switch (Hi-Hi) is installed above the high level switch that will run the solution delivery pump in case of an upset condition in the solution tank. A low level switch will protect the pump by preventing it from running dry.

e. Electrical Requirements

- 1) Two electrical circuits are required for operation: (1) 110v 15 amp power, and (1) 110v control circuit from a pool controller.

B. pH Buffering System (Muriatic Acid)

1. Chemical feeders for muriatic acid shall be peristaltic type pumps. Chemical feed pump(s) shall be provided and connected to the filtered water return lines to the pool(s) as shown on the pool plans. The pump(s) shall be capable of feeding a solution to the pool(s) to maintain pH level against the back pressure involved and shall be fully adjustable while in operation.
2. The pump(s) shall be provided complete with fractional horsepower motor for 120V 60 Hz current, plastic feed lines, and fitting necessary for connections to pool system piping.
3. The chemical pump(s) shall be electrically connected to, and operated by the water chemistry controllers.
4. The acid pump(s) shall be affixed with a metallic stamped label indicating the chemical being pumped and the pool to which it is connected.
5. Provide non-metallic wall mounted shelf support for the chemical feeder(s).
6. Provide five (5) fifteen (15) gallon acid drums.
7. Provide two (2) two drum modular spill platform. Platform shall be molded high-density polyethylene with removable polyethylene grating. Platform shall be 26.25" x 51.5" x 6.5" with a spill capacity of 30 gallons and a load capacity of 5,000 pounds. Platform shall be an Eagle two drum modular spill platform model 1632, or approved equal.
8. Provide "Vapor Shield" vent check valve for the acid drum/tank which seals container while allowing the liquid to be removed via pump. The Vapor-Shield shall prevent an internal vacuum and collapse of a sealed container. It will also prevent the pump from developing a vacuum-lock while attempting to remove the liquid from the sealed container. The Vapor-Shield shall prevent the release of any acid vapors. The Vapor-Shield body shall be constructed entirely from schedule 80 PVC with polypropylene tube fittings and factory-installed acid resistant viton sealant on all threaded connections. The diaphragm and o-rings shall be constructed of acid resistant viton. No metallic or materials not rated appropriate for use with acid shall be used. The Vapor-Shield shall be fitted with a ¾" male NPT threaded fitting to allow for the installation onto any common: five (5) through fifty-two (52) gallon acid shipping container caps and lids. The unit shall be supplied with no less than fifteen (15) feet of 3/8" polyethylene tubing. Recreation catalog no. 52-095. An Acid Fume Scrubber, part #7747090, with refill reagent kit, #7747091, manufactured by ProMinent shall be considered an equal.
9. Chemical feeders to be manufactured by G. H. Stenner & Co., or approved equal.
 - a. Competition Pool Acid Pump (one required): Model 45M3 22 GPD

- b. Training Pool Acid Pump (one required): Model 45M3 22 GPD
- c. Dive Pool Acid Pump (one required) (Alt #2): Model 45M3 22 GPD

C. Ultraviolet Dechloramination and Disinfection System

1. Ultraviolet Disinfection Equipment: Shall operate within the UVC electromagnetic spectrum emitting wavelengths in the range of 200nm to 400nm. This required wavelength will provide constant disinfection/inactivation of bacteria, algae, molds, viruses and destruction of Monochloramines, Trichloramines, and Dichloramines. Ultraviolet Lamp/Chamber and Spectra Touch Control Panel by Engineered Treatment Systems or Architect/Engineer approved equal. Any deviation/exception must be provided in writing to and approved by the designer prior to the bid date.
 - a. Ultraviolet disinfection equipment by Aquionics and Prominent are approved equals.
2. The UV System shall have an MET or equivalent (ETL, CSA, or UL) listing, be NSF-50 2014 certified including Section 14.18 (crypto inactivation) or 3rd party validated to the USEPA UVDGM 2006 Guidelines.
 - a. Equipment General Description: The Ultraviolet System shall be provided in a complete package to include: 316L Schedule 10 Stainless Steel Chamber, Spectra Touch Control System located in a NEMA 12 (IP52) rated panel, Medium Pressure Bulb(s) designed to emit wavelengths within the UVC electromagnetic spectrum, UV EZ Clean strainer, automatic wiper system, and Project Commissioning by a Certified ETS Ultraviolet Technician.
3. ECF Units: Ultraviolet manufacturer to offer unit capability of a horizontal OR vertical installation application using state of art design and direct flow through characteristics. Direct flow will be required in order to reduce total head loss through the system. Unit shall be a Multiple Lamp medium pressure system with a bulb range of (2) 1.0 kW – (4) 3.0 kW power range. Multiple lamp system is required in order to maintain quality disinfection in the event of a single bulb failure. ANSI or PN (as specified) flange range of 4"/100MM – 12"/300MM and flow pattern of 350 to 3700 GPM (1540 m3/hr to 16,313 m3/hr). @ 94% UVT. Any systems validated or designed for flows based on 98 % UVT are not acceptable. Chamber and Control Cabinet shall be as indicated on the drawings. Electrical requirements are indicated in the table below. The electrical contractor is to take into account plus/minus 3% for external breaker. All required electrical work to be performed by licensed electrician.

| Pool Type | Model Number | US EPA 3-log and calculated 40mj/cm2 (GPM) | Calculated 60 mj/cm2 (GPM) | Lamps | Power (KW) | Voltage (V) with Breaker Size |
|---------------|--------------|--|----------------------------|---------|------------|------------------------------------|
| Competition | ECF-225-10V | 1310 | 1230 | 2–2.5kW | 5.0 | 480 V (3φ)– 40A |
| Training | ECF-210-4V | 540 | 350 | 2–1.0kW | 2.0 | 208 V (1φ)– 20A 220 V (1φ)– 20A |
| Dive (Alt #2) | ECF-210-4V | 540 | 350 | 2–1.0kW | 2.0 | 208 V (1φ)– 20A 220 V (1φ)– 20A |

4. Ultraviolet Chamber

- a. Pressure rated for 100 psi/8 Bar (tested to 150 psi/11 Bar), and pressure drop across the unit will be minimal. The unit shall be constructed of 316L stainless steel, schedule 10 pipe, passivated to prevent corrosion within the harsh pool environment. The Ultraviolet chamber shall come complete with the following equipment.

- I. Ultraviolet intensity monitor factory calibrated to provide intensity in mw/cm^2 , it must include a built-in alarm system to notify operator when output level drops below required level of 60 mj/cm^2 for indoor pools or 40 mj/cm^2 for outdoor pools (or operator set dosing levels).
- II. Ultraviolet temperature control system shall be provided to maintain system integrity in the event of flow interruptions to the chamber.
- III. Ultraviolet chamber shall come complete with annealed quartz sleeve with "O" ring seals for water tightness.
- IV. Chambers shall be complete with ANSI or DN flanges (as specified) and all ports or vents shall be threaded NPT. The Ultraviolet chamber must be capable of installation in the system so that it remains full under all conditions.
- V. The Ultraviolet unit must be complete with integrated brackets or feet for ease of installation in either vertical or horizontal mounting.
- VI. The Chamber shall have a sacrificial anode attached to the chamber, extending inside the chamber and be bonded to the installation bond loop.

5. Ultraviolet Lamp

- a. Ultraviolet lamp shall be medium pressure high intensity. Lamp shall be designed to emit continuous Ultraviolet wavelengths in the range of 200nm to 400nm. This will provide optimal disinfection benefits and destruction of the Monochloramine, Dichloramine, and Trichloramine compounds. Lamp must remain unaffected by temperature variance of 0 degrees F (-17 C) to 200 degrees Fahrenheit (93 degrees Celsius).
- b. The lamp system must provide a constant dose of not less than 60 mj/cm^2 until the end of the lamp life for indoor applications and not less than 40 mj/cm^2 for outdoor disinfection and this must be based on constantly monitoring the full recirculating flow rate, not on a side stream treatment. The system must be equipped with variable power control to control the intensity & dose of the lamp in 1% increments.

6. Automatic Wiper System

- a. An automatic cleaning system shall be provided for cleaning of quartz sleeve and Ultraviolet monitor probe. The system shall travel the entire length of the quartz sleeve twice per desired cleaning cycle. Precision molded wiper rings shall be provided to ensure thorough quartz tube cleaning and quartz tube protection. Wiper cycle shall be user selectable and adjustable within a range of 5 minutes to 24 hours depending on anticipated application and deposit build-up.

7. UV Strainer

- a. The UV system must be provided with a downstream strainer to protect against the possibility of lamp/quartz breakage traveling downstream.

8. Ultraviolet Control System

- a. Control cabinet shall be an ETS SPECTRA Touch control unit and or pre-approved equal. The cabinet shall be an epoxy coated NEMA 12 / IP52 rated cabinet. If mounted outdoors it must be a NEMA4X /IP56 rated cabinet with an integral A/C unit to protect the components from the environment. The power must be controllable to provide full power, half power and infinite variable power based on real time interface with changes in UVT,

Flow Rate or Combined Chloramines. Three levels of operation shall be provided to meet the needs of the operator and pool environment: Simple Control (start, stop and reset), Full Parameter Display, and Customized Operator Configuration. Modes of operation shall be password protected to secure system critical setup functions. Touch Control system shall have clearly identifiable start, stop, and reset icons (suitable for gloved operation) with Running and Fault LCD indicators.

- I. The main Touch screen shall display a minimum of the following: Ultraviolet calculated dose (derived from flow and intensity inputs), Ultraviolet intensity (as a % and mw/cm²), Lamp Current, Flow rate (accepts signal from optional flow meter – displayed as gallons per minute or m³/hour), Chamber temperature (displayed as deg. F or deg. C), Operation hour meter, and fault indicators to include Lamp fault, low Ultraviolet & temperature alarm, Ground fault trip, Wiper fault. All alarm functions shall have simple text message display to assist in fault finding.
- II. Touch Control system shall have a minimum of the following system interface controls: Remote operation, Process interrupt features (from valves, flow meters), Low UV dose (configurable to shutdown or alarm only), Flow meter input, Auto-Restrike, Half to full power Ultraviolet setting with 24 hour/7 day settable timer. Variable power/Dose pacing interface.
- III. Touch Control system shall have built in data-logging capabilities to record the following information: Ultraviolet intensity required, Ultraviolet intensity measured, Lamp current, Chamber temperature, Flow rate (if flow meter is connected), Time and date stamp, All alarms generated.
- IV. Touch Control system must be able to be interfaced with a Chemistry Controller that can measure Total or Combined Chloramines in order to maintain the proper dosage required during the life of the lamp.
- V. Touch Control system must be able to interface with any automatic or semi-automatic filtration controller.
- VI. Touch Control system must be capable of operating through Ethernet or Wi Fi.
- VII. Touch Control system must be capable of interfacing with a SCADA system including both Profibus and Modbus.

9. System Startup

- a. Install in accordance with contract documents and manufacturer's instructions.
- b. Commissioning:
 - I. Ultraviolet Chamber and Control Panel shall be commissioned by a qualified factory trained technician to institute the warranty.
 - II. Final electrical and control cabling will be connected from the Touch Control cabinet to the Ultraviolet disinfection chamber during the commissioning process.
 - III. Daily operation and simple maintenance instructions shall be provided during the commissioning process.

10. Warranty

- a. All components, excluding lamps, quartz and seals, shall have a limited warranty to be free from defects in workmanship and materials for a period of 12 months from date of start-up. Medium pressure Ultraviolet bulbs shall be warranted for a period of 8,000 hours. Intermittently operated lamps (□ 1 on/off cycles per day) will be replaced free of charge should failure occur prior to 4,000 hours and replacement will be prorated between 4,000 and 8,000 hours.
- b. Manufacturer must maintain spare or replacement parts in the USA for same day or not longer than next day delivery in North America.

D. Calcium Thiosulfate (Dechlorination)

1. Chemical feeder for chlorine dechlorination shall be peristaltic type pumps (one (1) required). Chemical feed pumps shall be provided and connected to the backwash funnel pipe as shown on the plans. The pump shall be capable of feeding a solution to the backwash funnel at a rate to effectively dechlorinate the pool waste water prior to being discharged to the sewer system. The pump shall be provided complete with fractional horsepower motor for 120V, 60 Hz current, plastic feed lines, and fitting necessary for connections to the pool backwash funnel piping.
2. The pumps shall be affixed with a metallic stamped label indicating the chemical being pumped and the pool to which it is connected.
3. Wall mount or provide non-metallic shelf support for the dechlorination feed pumps.
4. Chemical feeders to be manufactured by G. H. Stenner & Co., or approved equal.
 - a. Dechlorination Pump (three required): Model 45MJH2 10 GPD (each)
5. All feeder systems to be provided with a saddle mount injector port as shown on the drawings. Saddle mount shall be made of PVC with stainless steel clamps and have ½" FNPT threads. Saddle mount shall be manufactured by Pulsafeeder supplied by Pollard Water, or approved equal.
6. Provide one (1) 5-gallon bulk calcium thiosulfate container in the mechanical room as shown on the drawings. Tanks shall be 12"x9.75"x14.75". System shall be Captor NSF for dechlorination supplied by Pollard Water, or approved equal.
7. Provide one (1) one drum modular spill platform. Platform shall be molded high-density polyethylene with removable polyethylene grating. Platform shall be 26.25" x 26" x 6.5" with a spill capacity of 15 gallons and a load capacity of 2,000 pounds. Platform shall be an Eagle one drum modular spill platform model 1633, or approved equal.

2.7 WATER CHEMISTRY MONITORING AND CONTROL SYSTEMS

- A. The water chemistry control system for the competition/training/dive pool (Alt #2) shall provide continuous monitoring and control of sanitizers, oxidizers, pH, ORP, free chlorine, temperature, system flow rate, total dissolved solids (TDS) and water chemistry balance calculations. The controller shall manage the recirculation pump with a programmable Fireman Cycle feature, which automatically turns off the Heater, UV and Auxiliary systems prior to shutting off the recirculation pump. All line-voltage wiring shall be performed in a separate NEMA 4X enclosure that precludes access to the controller electronics. Installation of the system shall be per the manufacturer's specification and no exceptions shall be allowed. A factory trained/authorized representative shall provide training to the Owner and the training shall be videotaped per 131100, Section 1.12 of the project contract documents. The specified controller, a BECSys7 manufactured by BECS Technology, Inc. shall be provided or Chemtrol by SB Control Systems,

AcuTrol by Pentair, ProMinent, or a technically equal system capable of providing equal performance for all operating functions.

B. Certifications

8. The controller shall carry the following product certifications

- a. NSF/ANSI Standard 50;
- b. UL 61010-1

C. Sensors

1. The controller shall come with the following sensors

a. pH - The controller shall provide a measurement of pH by utilizing a sensor with the following characteristics:

- 1) 0 – 14 sensing range
- 2) ABS body with ½" NPT process connection
- 3) Minimum of 32 milliliters of inorganic electrolyte gel; organic electrolytes, susceptible to breakdown in the presence of strong oxidants, shall not be considered equal
- 4) A porous Teflon liquid junction to provide a stable, low impedance reference contact, and to prevent fouling and clogging of the liquid junction
- 5) A silver/silver chloride (Ag/AgCl) reference element
- 6) A general purpose glass membrane pH sensing element
- 7) Operating temperature range of 0 - 80 degrees C
- 8) Operating pressure range of 0 - 100 psiG.
- 9) The controller shall continuously monitor, display and data log pH with 0.1 or 0.01 resolution (programmable).

b. ORP - The controller shall provide a measurement of ORP by utilizing a sensor with the following characteristics:

- 1) -1000 to +1000mV sensing range
- 2) ABS body with ½" NPT process connection
- 3) Minimum of 32 milliliters of inorganic electrolyte gel; organic electrolytes, susceptible to breakdown in the presence of strong oxidants, shall not be considered equal
- 4) A porous Teflon liquid junction to provide a stable, low impedance reference contact, and to prevent fouling and clogging of the liquid junction
- 5) A silver/silver chloride (Ag/AgCl) reference element

- 6) A solid platinum or solid gold ORP sensing element with a minimum of 1 cm² surface area; platinum-plated and gold-plated sensing elements, which are susceptible to abrasives, shall not be considered equal
- 7) Operating temperature range of 0 - 80 degrees C
- 8) Operating pressure range of 0 - 100 psig
- 9) The controller shall continuously monitor, display and data log ORP with 1mV resolution
- c. Flow Sensor - The controller shall provide a measurement of pool circulation flow rate and volume by utilizing a flow sensor with the following characteristics:
 - 1) 0-8800 gpm (0-33265 liter/min) measuring range,
 - 2) Magmeter flow sensor with a frequency output,
 - 3) Dual O-ring seal,
 - 4) Cable to meet length requirement for installation,
 - 5) Saddle to meet return line size,
 - 6) Flow volume: 999 trillion gallons, 1 gallon resolution; 999 trillion liters, 1 liter resolution.
 - 7) The controller shall continuously monitor, display and data log flow rate with 0.1 gpm resolution.
- d. Temperature - The controller shall provide a measurement of water temperature by utilizing a sensor with the following characteristics:
 - 1) 32 – 212°F (0 – 100°C) sensing range;
 - 2) 2 wire, 100Ω resistive temperature detector (RTD) with a 0.00385 Alpha.
 - 3) The controller shall continuously monitor, display and data log temperature with 1°F resolution.
- e. Free Chlorine Sensor - The controller shall provide a measurement of free chlorine by utilizing an amperometric sensor with the following characteristics:
 - 1) 0.0 to 20.0 mg/l (ppm) measuring range with fully selectable scale,
 - 2) 32° - 113°F operating temperature range,
 - 3) A PVC body,
 - 4) Replaceable PTFE membrane and electrolyte,
 - 5) Gold cathode and silver/silver chloride anode.
 - 6) The controller shall continuously monitor, display and data log free chlorine with 0.1 mg/l resolution.

D. User Interface

1. Standard Display - The standard display shall be a backlit transfective LCD with 14 line x 40 alpha/numeric graphical characters that will continuously display information related to the following:
 - a. All installed sensor readings
 - b. Set points, with current control status
 - c. All active alarms, including time activated
 - d. Smart menus w/ integrated on-screen help
 - e. Contrast adjustment of the backlit LCD shall be provided through clearly marked keys on the front-panel without the need for access to internal controller circuitry. After initial adjustment, controller shall monitor internal temperature and automatically adjust contrast to prevent LCD blackout in extreme ambient temperature conditions. Controllers that do not include front-panel contrast adjustment and automatic temperature compensation shall not be considered equal.
 - f. The standard user interface shall include single-touch access to Set Points, Relay Modes, Calibrations, Backwash status and settings, Menu access, and Reset Fail/Safes. An alphanumeric keypad shall be provided for ease of system configuration.

E. Control Functions

1. Water Chemistry

- a. pH Control: The controller shall continuously control pH. Chemical feed shall be configurable for feed-up, feed-down, or dual feed and either on/off or time-based proportional feed.
- b. Sanitizer Control: The controller shall continuously control sanitizer based upon the ORP reading, the amperometric sensor, or both with a bracketed control program. Chemical feed shall be configurable for either on/off or time-based proportional feed.
- c. Bracketed Sanitizer Control: With the amperometric ppm sensor, the controller shall be configurable for bracketed sanitizer control; The bracketed control algorithm shall allow either the ORP or ppm setpoint to be chosen as the primary control point, while using other parameter to create a secondary boundary (min and max settings) that must be maintained in addition to the primary control point.
- d. Sanitizer Booster Feed: The controller shall have a sanitizer booster program with selectable ORP and/or ppm set points with separate ending set points, allowing the option of the booster sanitizer to control to a lower set point while the primary system can recovers.
- e. UV Control: A Fireman Cycle feature shall turn off (ramp down) the UV relay 0 to 60 minutes (settable) prior to backwash initiation or recirculation pump shutdown.
- f. Auxiliary: A Fireman Cycle feature shall turn off (ramp down) the Auxiliary relay 0 to 60 minutes (settable) prior to backwash initiation or recirculation pump shutdown. The Ozone Fireman control and relay shall have the ability to be renamed in the menus to provide the Fireman Cycle feature for Auxiliary equipment instead of ozone as needed.

- g. Superchlorination: The controller shall have a programmable superchlorination function, based upon ORP or ppm superchlor setpoint, which is triggered manually.
 - h. Dechlorination: The controller shall have a programmable dechlorination function, based upon ORP or ppm dechlor setpoint, which is triggered either manually or by the completion of the superchlorination function.
 - i. LSI & RSI: The controller shall compute the Langelier Saturation Index and the Ryznar Saturation Index based upon current inputs and the Ca Hardness and Alkalinity entered by the operator.
2. Expanded
- a. Flow Monitoring: The controller shall continuously monitor, display, and datalog system flow, maintaining a total flow volume. A Low Flow Alarm shall be operator settable, which can be programmed to disable chemical feeds. Controller shall also have a Minimum Flow Rate setting to turn off heater whenever system flow is less than this programmed minimum level.
 - b. Heater Control: The controller shall perform on/off control of a heater based upon an operator settable temperature set point. A Fireman Cycle feature shall turn off the Heater 0 to 60 minutes (settable) prior to recirculation pump shutdown. The controller shall immediately turn off the Heater when system flow is less than the heater Minimum Flow Rate setting. The Heater control algorithm shall include an Energy Conservation mode, with on/off set time and secondary temperature set point.

F. Main Recirculation Pump

1. On/Off Control with Relay
- a. Controller shall provide the capability to interface to and control a recirculation pump with a programmable relay. The controller shall provide 3 operator-settable independent Fireman Cycle settings and relays for the Heater, UV and Auxiliary controls. The controller shall include the following capabilities, available as appropriate based upon installed sensors and implemented features:
 - 1) Fireman Cycle: Upon the following events, the controller shall automatically delay recirculation pump shutdown until the Heater, UV and Auxiliary controls have been deactivated and the corresponding Fireman Cycles have expired:
 - a) Backwash Operations
 - b) Energy Conservation mode (24 hr., 7 day function)
 - c) Manual off (per Operator)
 - 2) Immediate: Upon the following events, the controller shall immediately turn off the recirculation pump (and Heater, UV and Auxiliary controls), without first satisfying Fireman Cycle timing requirements:
 - a) Surge Tank Level Low Alarm: Turn off pump immediately (surge tank is almost empty)
 - b) Strainer Vacuum High Alarm: Turn off pump immediately (possible entrapment)

- c) Emergency shutdown, triggered by front-panel Emergency Off: Turn off pump immediately (per Operator)

2. Total Dynamic Head (TDH)

- a. Controller shall provide the capability to continuously monitor the Total Dynamic Head (TDH) of the main recirculation pump, directly calculated by the controller from recirculation pump influent vacuum and filter influent pressure transducers. TDH shall be displayed on the user interface and recorded in data logs, with user-programmable High and Low TDH Alarm settings.

3. VFD Interface with 4-20mA signal

- a. Controller shall provide the capability to interface to and control a recirculation pump equipped with a Variable Frequency Drive (VFD) through a 4-20mA signal. The controller programming shall allow the operator to manage the VFD entirely from the water chemistry controller, by providing the following capabilities:

- 1) Programmable setpoint specified as either flow rate, effluent filter pressure, or fixed setting,
- 2) Four programmable operator-triggered alternate profiles ("Manual Turndowns"),
- 3) Four programmable scheduled alternate profiles ("Scheduled Turndowns"),
- 4) Override setting for backwash,
- 5) Ramp up and ramp down settings,
- 6) Minimum output setting.
- 7) Remote access to current VFD status and all VFD parameters shall be provided through the BECSys for Windows PC software provided with controller. The name of each alternate profile shall be changeable by the operator, so that VFD menus and data log entries are intuitive and recognizable by the users of the system.
- 8) Systems that do not provide both local and remote management of the VFD through the water chemistry controller shall not be considered equal.

G. Control Outputs

1. Relay Outputs

a. Solid-State Relays

- 1) The controller shall come with a total of 4 integral line or dry contact 5A solid-state relay outputs capable of switching 3A under all normal operating conditions, accounting for the effects of the temperature gradient inside the NEMA 4X enclosure. Systems that utilize relays that are not de-rated must submit an engineering evaluation justifying the use of relays at their full, optimal-condition capacity. All solid-state relays shall have a provision for an electrical interlock with the circulation pump motor starter.

2. Mechanical Relays

a. The controller shall come with a total of 5 mechanical relays:

- 1) 1 integral 8A dry contact mechanical relay, and
- 2) 4 integral 3A dry contact or line powered mechanical relays.
- 3) Since mechanical relays have the inherent risk of failing in the closed (active) position, as a safety measure the controller shall preclude the ability to assign any of the integral mechanical relays to chemical feed functions. Systems that do not preclude mechanical relays from being configured for chemical feeds shall not be considered equal. All mechanical relays shall have a provision for an electrical interlock with the circulation pump motor starter.

3. 4-20mA Outputs

a. The controller shall come with eight separately isolated 4-20mA output signals with a load capacity of 440Ω per output channel. Each output signal shall be independently configurable for either of the following functions:

- 1) Any enabled input, scaled between two operator-defined end points,
- 2) VFD control of recirculation pump.

H. Safety Features

1. Manual-On limit

- a. The controller shall have built-in limits to the amount of time any relay control output may be forced on (i.e. in "Manual On" mode). This is an important safety feature to prevent control outputs from inadvertently being left forced on after service or diagnostics.

2. High/Low Alarm Settings & Control Lockouts

- a. The controller shall have programmable high and low alarm settings for pH, ORP, PPM, temperature, low flow & no flow and chemical overfeed, turbidity, pressure & vacuum, surge tank levels, chemical inventory. The controller shall have a programmable lockout of sanitizer feed upon pH high or low alarm.

3. No Flow Alarm & Flow Restored Delay

- a. The controller shall activate a No Flow alarm when the dedicated sample stream flow switch indicates there is insufficient flow through the sample stream. This No Flow alarm shall lockout all chemical feed control operations. The controller shall include a Flow Restored Delay, which shall extend the No Flow lockout user-programmable amount of time after the No Flow alarm ends (i.e. flow is restored). This feature is necessary to assure that the system has valid, stable sensor readings of circulating water prior to making chemical feed control decisions.

4. Feed Limit Alarms

- a. The controller shall trigger a FailSafe alarm if a chemical feed relay remains on longer than the programmable Feed Limit Timer. Chemical feeds shall automatically be disabled if the corresponding reading goes into a FailSafe alarm condition.

5. Emergency Off

- a. The controller shall have a dedicated Emergency Off button on the front panel of the system, which immediately halts all chemical feeds and control outputs when pressed. This feature shall be password protectable, which shall require entry of one of the Security passwords.

6. Safety shield

- a. The controller shall include a safety shield or other mechanism for allowing fuse replacement without access to high voltage circuitry or wiring.

I. Security

1. The controller shall have three security password levels: six for operators, two for managers and one for the distributor providing for a history of access identified by the user.

J. Data Logging

1. The controller shall have 512K battery backed-up RAM for input level recording and events. All input level shall be recorded for 10 to 56 days depending on sample rate (2 to 10 minutes).
2. The controller shall record and maintain the latest 1100 events over a maximum of 14 days recording all alarms, parameter changes, user logins, and operational cycles related to all control features.

K. Local Alarms Indicators

1. The controller shall signal all alarm conditions with the following indicators:
 - a. A bright red flashing LED on the front of the controller,
 - b. Activation of a master alarm signal provided as a dry contact relay enabling the use of 0-240 VAC alarms, and
 - c. Each active alarm listed on the LCD display along with time activated.

L. Remote Communication, Access & Alarm Notification

1. Ethernet

- a. The controller shall come with a standard, integral 100BaseT Ethernet connection. The controller shall be capable of providing Remote Access via PC with Ethernet connection and Alarm Notification via email or text message via an Ethernet connection to the Internet.

2. Remote Access

- a. The controller manufacturer shall provide BECSys for Windowsä graphical remote operation software, for interactive connection to the controller from a PC. Remote operation software shall be Vista-compatible, and have all of the following operational modes:
 - 1) Site Data Base – for organizing and accessing multiple controllers on site, or at multiple sites.
 - 2) Graphical Operator's Console – to display current readings, setpoints, alarm points and control status in an easy-to-read graphical mode.
 - 3) Data Log Graphing – to review data logs with time-synchronized event data; data log traces shall be configurable, with color and line style selectable by operator.
 - 4) Full Menu Tree – All system parameters accessible through a full menu tree interface.
 - 5) Auto-Polling – to allow automatic download of data logs from all controllers in site database.

3. Alarm Notification

- a. The controller shall be capable of providing alarm notification to 8 different recipients. Each recipient shall be individually configurable to receive alarm notification by one of the following methods.
 - 1) Email: Notification message shall include system type, serial number, location, system ID, and all active alarm including the date and time each alarm was triggered.
 - 2) Text Message: Notification message shall include system type, serial number, location, system ID, and all active alarm including the date and time each alarm was triggered.
 - 3) Fax: Notification message shall include system type, serial number, location, system ID, and all active alarm including the date and time each alarm was triggered.
 - 4) Numeric Pager: Notification message shall include callback number. Controller shall acknowledge pager notification when callback is received, and not notify subsequent recipients programmed for pager notification.
4. CONTRACTOR TO VERIFY CONNNECTION TO BUILDING MANAGEMENT SYSTEM – PRIOR TO ORDERING CONTROLLER – Provide one of the following connections to the BMS (option 5 or 6).
5. Ethernet with MODBUS TCP/IP The controller shall come with a standard, integral 100BaseT Ethernet connection that supports a MODBUS TCP/IP connection to 3rd party applications such as EMS, BMS, BAC and SCADA systems. The MODBUS TCP/IP connection shall support access to Inputs (current readings), System Information, Set Points, Alarm Points, Control Status and Alarms. Set Points and Alarm Points shall be modifiable from the 3rd party application via the MODBUS TCP/IP interface.
6. The controller shall support an MS/TP (RS485) or TCP/IP (Ethernet) BACnet connection to 3rd party applications such as EMS, BMS, BAC and SCADA systems. The BACnet connection shall support access to Inputs (current readings), System Information, Set Points, Alarm Points,

Control Status and Alarms. Set Points and Alarm Points shall be modifiable from the 3rd party application via the BACnet interface.

7. Wi-Fi

- a. The controller shall come with a BECSys Wi-Fi module, which allows wireless integration into existing Wi-Fi networks.

8. EZ Connect

- a. The controller shall come with an integral 1 Gbit Ethernet connection. Through this Gbit Ethernet connection the controller shall be capable of providing:
 - 1) Local and remote access via PC
 - 2) Local and remote mobile access with an Android and iOS Mobile App
 - 3) Alarm notification via email or text message via an Ethernet connection to the Internet
- b. The controller shall have 512 MB NAND flash memory, which does not require a battery to preserve data logs during power outages, for input level recording and events. All input levels shall be recorded and maintained for 365 days on the controller, with a sample taken every minute. The controller shall record and maintain the events over the last 365 days recording all alarms, parameter changes, user logins, and operational cycles related to all control features. Systems that require a battery to preserve data logs during power outages shall not be considered equal.
- c. Local and remote access shall be available through the BECSys EZConnect™ system. The EZConnect™ system eliminates the need for IT departments to make special router/firewall allowances for access to the controller from outside the network, such as port forwarding and VPNs. Controllers that require a VPN or port forwarding for remote access shall not be considered equal. Messages to/from the controller shall be protected with TLS encryption for maximum security. EZConnect™ shall be disableable, in which case traditional IP-based techniques can be used to access the controller.
- d. The controller shall also support a MODBUS TCP/IP connection to 3rd party applications such as EMS, BMS, BAC and SCADA systems. The MODBUS TCP/IP connection shall support access to Inputs (current readings), System Information, Set Points, Alarm Points, Control Status and Alarms. Set Points and Alarm Points shall be modifiable from the 3rd party application via the MODBUS TCP/IP interface.

M. Enclosures

- 1. The controller shall be housed in a NEMA 4X polycarbonate enclosure.
- 2. Field wiring enclosure: All high voltage field wiring shall be through a separate NEMA 4X enclosure that precludes access to controller electronics. All high voltage connections shall be clearly identified and a field wiring diagram shall be provided with the controller for installer reference. All controller high-voltage relay assignment parameters shall be programmed at the factory prior to delivery to installation location.

N. Flow Cell

1. PVC flow cell

- a. The flow cell shall have a PVC body with two ½" NPT ports for pH and ORP sensors, two ¼"NPT ports for temperature sensor and sensor wash acid injection, and a clear acrylic front viewing window. The flowcell design shall provide precise sample flow rate and water velocity regulation past the probes. The flowcell shall come provided with PVC ½" isolation ball valves, PVC ¼" wet test valve and standard reed or optional rotary flow switch.
- b. Each flow cell shall be equipped with a pressure-sensing device. The pressure sensor shall consist of a compound pressure/vacuum gauge manufactured in stainless steel, 2 ½" diameter, liquid filled with an operating pressure range of 0 to 60 psig and vacuum of 0 to -30 in./ Hg.

O. Start-up and Manuals

1. The control system shall be provided with on-site start-up, on-site operator training, and 1 year on-site warranty service performed by a representative trained and authorized by the controller manufacturer.
2. Manufacturer shall supply an Operation and Maintenance Manual describing features, operating instructions, maintenance procedures and replacement parts.

2.8 FLOW METERS

A. Flow Meter

1. Flow meters (3 required) shall be installed according to the manufacturer in the filtered water return lines to each of the pools. Flow sensor shall be the GF Signet 2551 insertion magmeter. Provide the coaxial cable from the sensor to the display/transmitter. Flow meter accuracy shall be +/- 2% of reading. The flow instrument shall have a LCD for simultaneous display of four-digit flow rate and eight-digit totalizer. Display/Transmitter capability will be part of chemical controller function or as separate Signet GF Signet 9900 display/transmitter. Signet GF Signet 9900 display/transmitter shall be powered by 24VDC and provide a 4-20mA output.
2. Backwash piping flow meter (3 required) shall be a pilot, impact ball, variable area type with one piece, impact resistant machined acrylic plastic body. GPM scale to be permanently etched or imprinted on the meter. Flow rate indicator to be of stainless steel material. Scale range to be appropriate for specific flow rate. Pipe size to accommodate backwash rate. Backwash piping flow meter shall be BLUE-WHITE series F-300 or approved equal.

2.9 WATER LEVEL CONTROLLERS

A. In Surge Tank Water Level Controller

1. Provide a water level sensing and control system for each of the Competition Pool /Training Pool /Dive Pool (Alt. #2) that will monitor the water level in the surge tank and automatically activate the auto water make-up control valve. For sensing water level and activating make-up water control valve for each pool, use Series ELC-810 Controller housed in a watertight NEMA 4X UL94 5V UL flammability rated polycarbonate enclosure to meet IP66 and NEMA 4, 4X, 12 and 13 ratings. The Controller shall utilize two sensor(s) to control water level. ELC-810 series shall have a menu-driven LCD display screen and utilize a five-switch user interface for navigation through the menu. The menu shall allow changing the following settings: delay to shutoff, alternate sensor option, maximum time on, manual override, delay to normal, type of sensor, high level option, flow sensor active, and sounder with alarm. All menu settings shall be capable of password protection. The Controller shall be capable of displaying the following

data: last fill time, last drain time, last alarm. The Controller shall be capable of determining the following: maximum time on exceeded, over current to solenoid valve, no valve/valve wiring problem, and sensor not working properly. The Controller shall have a low voltage interlock with auto water make-up solenoid valve, shall provide adjustable time delay for increasing level and manual override; and shall require 115 VAC, 1 phase, 60 Hz power. Manufactured by AquatiControl Technology, Model ELC-810-DS-ST-XXX (Contractor to coordinate the specific length(s) of cable required for each controller prior to ordering). Refer to drawings for additional information. Provided and installed by CONTRACTOR and connected by electrical.

2. Provide a solenoid valve for high level sensor, normally opened, stainless steel fitted, bronze body, 24 VAC slow closing type. Size to pipe. Interlock with automatic water level control system. Refer to the Drawings for additional information. Such as ASCO, or approved equal.
3. Provide a proximity switch sensor that shall be sensitive to within +/- 1/8" (4mm) of nominal water level. Supply voltage to sensor shall be 12V to 24V DC from Controller. Current consumption shall be < or = 15mA. Response frequency shall be 100Hz. Maximum control output shall be 200mA. Sensor operating temperature shall be -25 Deg. C to 70 Deg. C. Operating humidity shall range from 35% RH to 95% RH. Sensor shall be mounted in a 1" SCH80 PVC pipe (length to be determined by depth of surge tank). Sensing pipe to be mounted to surge tank wall with composite/non-metallic hangers and stainless steel hardware. Sensing pipe shall be capable of being submerged under water safely. Refer to drawings for additional information.
4. Wiring from the sensor to the Controller shall be provided and shall be connected to the terminal points mounted within a corrosion-resistant, nonmetallic NEMA 4X enclosure. All wiring connections shall be made through the bottom of the enclosure. The enclosure size shall be no less than 8" wide x 5" high x 4" deep. The access door shall be the entire front face panel of the enclosure. Confirm location in field.
5. Major components shall be plugged in using WAGO terminal blocks for ease of installation and replacement. Unit shall be designed to activate a 24-volt AC solenoid valve.
6. Provide a make-up water solenoid valve, normally closed, stainless steel fitted, bronze body, 24 VAC slow closing type. Size to pipe. Interlock with automatic water level control system. Refer to the Drawings for additional information. Such as ASCO, or approved equal.
7. Discharge of make-up water shall be into a fill standpipe and piping to the Competition Pool / Training Pool / Dive Pool (Alt. #2). Refer to the Drawings for additional information.

2.10 INSERTS AND ANCHOR SOCKETS

- A. Sockets and anchors shall be provided as stainless steel or cast bronze for swimming pool accessories. The CONTRACTOR shall confirm compatibility of deck equipment and deck anchors with the deck equipment manufacturer. All anchors or sockets shall be provided with flush closure caps and escutcheons with set screws where indicated. Escutcheons shall be of the keyhole or oblong shape, similar to the casted, electro-polished stainless steel escutcheon with set screw by Paragon #28303SS, or approved equal.
 1. Anchor sockets for all railings and grab rails shall be of the wedge type, cast bronze, 4 inches in depth and made to receive 1.50 inch OD tubing as manufactured by Paragon #28105, or approved equal. The wedge shall be cast bronze, incorporate a stainless steel tightening bolt and flat washer, and be designed as the sacrificial element to the anchor system. All metallic components shall be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance.

2. Anchor sockets for all stanchions and water polo goals shall be of cast bronze, sized to receive a full 6 inches penetration of 1.900 inch OD tubing as manufactured by Paragon Aquatics Catalog No. 38201TC, Spectrum Products No. 23626, Kiefer No. 700103, or approved equal. Each anchor socket is to be provided with a flush threaded, vandal proof closure cap Paragon Aquatics Catalog No. 38201TC or Spectrum Products No. 23628, or Kiefer No. 700103C, and a grounding lug with screw. Provide Paragon Aquatics catalog no. 38303, Spectrum Products catalog no. 23630, Kiefer No. 700103K, or approved equal spanner wrenches for removing the closure cap.
3. Cup anchors for racing lane lines, water polo tether and boundary lines etc. shall be incorporated into the perimeter overflow system. Cup anchors shall be 316L stainless steel with stainless steel threaded eyebolts. The heavy-duty cup anchors shall be 3-3/8" in diameter. Cup anchors shall be Spectrum round cup anchor, part no. 58280, SR Smith Lane Line Wall Anchor, part no. WA-100, or approved equal for the competition pool. Cup anchors shall be KDI Paragon, model number 14-505 at the training pool.
4. Anchor sockets for single post starting platforms located on the rollout gutter, shall be designed to prevent rocking. A stainless steel cap shall be provided to flush mount on the deck when platform is removed. Anchor socket shall be cast T304 stainless steel with wedge assembly consisting of a bronze wedge and T304 stainless steel hardware. Anchors for starting platforms shall be by the starting block manufacturer - Quickset Dual-wedge anchor by KDI Paragon, SR Smith Rock Solid anchor, Record Breaker anchor by Spectrum, or Riptide anchor by Kiefer.
5. Anchor assembly for pool lift shall be a pair of threaded bronze anchor sockets mounted on a jig. The anchor assembly shall include a grounding lug for proper bonding. Install in accordance with manufacturer's instructions and provide the concrete foundation reinforcing required to properly anchor and support the unit for its intended use. Manufacturer shall provide an anchor that has a completely flush cover or flush plug for times when the lift is not in use.
6. Anchors for the diving board stands shall be all bronze threaded castings for respective 5/8" threaded anchor bolts. The stand shall be designed for mounting with the use of Duraform catalog number 70-231-900 bronze deck anchors.

2.11 DECK EQUIPMENT

- A. Grab rails shall be provided as required in the quantities and to the dimensions as shown on the drawings. Grab rails shall be fabricated of one continuous length of polished and buffed tubing. The tubing shall be ASTM-A-554 grade 304L stainless steel, 1.50 inch OD x .120 inch minimum wall thickness, polished and buffed to 320 grit finish and shall be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance. All bends shall be smooth and free of wrinkles. Grab rails shall be pretzel bend style with dimensions as indicated in the plans and as manufactured by Spectrum, SR Smith, Paragon, or approved equal.
- B. Ramp & Stair Entry rails shall be provided as shown on the drawings, fabricated from one continuous piece of polished and buffed ASTM-A-554 grade 304L stainless steel, 1.500 inch OD x .120 inch wall thickness, polished and buffed to 320 grit finish and shall be passivated for maximum corrosion resistance. Bends shall be smooth and wrinkle free. Custom rails shall be as manufactured by Spectrum Products, or approved equal. Custom rail submittal drawings shall be complete with details of custom fabrication and installation information.
- C. Stanchion posts (backstroke and false start) shall be provided as required and in the quantities shown on the drawings. The posts shall be a straight length of type 304L stainless steel tubing, 1.900 in. OD x .145 in. wall thickness x 8 ft. 0 in. overall length, polished and buffed to 320 grit finish. Stanchions shall be capped at one end with a closure plug containing a U-shaped hook and

fitted with a stainless steel eyebolt attached to an adjustable nickel plated bronze sliding collar. Stanchion shall be as manufactured by Paragon Aquatics, catalog no. 38106, or Spectrum Products catalog no. 23614 with Paragon Aquatics catalog no. 38301 or Spectrum Products catalog no. 23625, sliding collar, with eyebolt or approved equal.

D. Starting Platforms

1. Single post starting platforms for the rollout gutter (11 required, 10 plus 1 spare) shall have number plates on both sides numbered 1 through 10. Spare block shall not be numbered. Platform block height shall be 29-1/2" inch above water level. The platform top (24" wide x 32" deep) and intermediate rear step (8" x 12") shall be constructed of UV inhibited high density polypropylene. The surface shall have a non-skid dual cross-grooved sand textured finish. The top shall be permanently positioned at a 10° tilt towards the pool. Frames to be 2.5 square inch x .125 inch wall thickness 304 stainless steel tubing with a powder coated finish. Architect/Owner to select colors. Verify height of platform above water before ordering. Backstroke bar shall be 1" diameter and allow both horizontal and vertical grab positions. Blocks shall have raised side grip handles and adjustable back plate. Platforms shall be custom blocks as detailed on the plans similar to the Paragon Track Start Quickset, Legacy starting platform by SR Smith, Keifer Riptide, Spectrum Record Breaker, or approved equal. Each starting platform shall have two labels affixed stating "Warning-Execute Shallow Racing Dive - Impact with Pool Bottom can Cause Permanent Injury."
2. Starting platform safety covers (10 required) are designed to keep unwanted users off starting platforms. The cover is made of 1/16" thick tough, lightweight plastic with a UV stabilizer and fits 20" x 24" platform tops. The conical shape and safety orange color act as a deterrent of starting platform use. Each cover is provided with a bungee cord for securing cover platform top.

E. Water Polo Goals

1. Goals shall be constructed to meet all official regulations of FINA, NCAA, NFSHSA, and USWP. Where a conflict exists between these specifications and the official regulations of FINA, FINA shall govern. Special finishes and backings shall comply with the regulations. Deck-mounted water polo goals shall be adjustable vertically to provide the regulation cross bar elevation in shallow or deep water.
2. Floating water polo goal (2 required) shall consist of a front frame made of non-corrodible 3 inch x 2 inch aluminum with rounded edges and supported by 1 1/4" non-corrodible polished pipe. The flotation unit shall be vacuum formed ABS plastic supported by high-density ethafoam. The floating goal shall be as manufactured by Anti-Wave Club, Anti-Wave Odyssey, Kiefer KAP204, Kiefer WPG1402, or approved equal. The goal shall be provided with mesh netting securely fastened to the cage. Goal shall incorporate attachments for wave quelling cable floats, hooks and take-up ratchet for securing to rope anchors.

F. Lifeguard Chairs

1. Lifeguard chairs shall be constructed of UV inhibited recycled HDPE chairs. Maximum seat height shall be 48" and 66" above the pool deck. All joints shall be secured using T- 316L stainless steel screws. Chair shall include umbrella guide and holders. Refer to architect for color finish.
 - a. Lifeguard chairs (4 required) shall be Spectrum Mendota #45023, Tailwind Furniture model no. LG510, Kiefer Forever Guard Chair model no. 500231, SR Smith Sentry #SLGC42, or approved equal.

- b. Lifeguard chairs (1 required) shall be Spectrum Mendota #45023, Tailwind Furniture model no. LG510, Kiefer Forever Guard Chair model no. 500231, SR Smith Sentry #SLGC42, or approved equal.

G. Diving Stands

- 1. Diving stands for the one-meter/three-meter springboards shall be installed as shown on the plans. The diving board stand shall consist of heavy aluminum castings dipped in erudite chromic acid solution, followed by a 20 mil coat of baked epoxy. Finish must be touched up in the field if damaged in shipping or assembly. The roller tube and tracks shall be heat-treated extruded aluminum processed by Alcoa Duranodic hard anodizing process. The bearings for the roller tube and slide shall be nylon with grease fittings, adjustable and field replaceable. The diving board anchor hinges and pins shall be heat treated aluminum forgings with a design tensile strength of 35,000 psi and shall receive Alcoa Duranodic hard anodizing. Hinges shall be designed to allow 180-deg. rotation of the diving board to the rear of the stand. Hinges shall be mounted on a transverse casting machined to allow 7 leveling positions in one-inch increments. The diving board anchor bolts shall be 5/8-inch diameter by 3-1/2 inch long silicon bronze. The diving stand shall be supplied with top and intermediate guard rails on two sides. The diving stand guard rails shall be stainless steel tubing firmly attached to the guard rail supports with stainless steel band fasteners. The rails shall extend to the edge of the swimming pool and the rail ends shall be fitted with rubber safety tips. Fulcrum shall have an adjusting wheel at one end that can be turned by hand or foot. Diving stands to be as manufactured by Duraflex International Corp.

- a. One meter stand (1 required) shall be Duraform catalog #70-231-400 and included with eight (8) bronze deck anchors, Duraform catalog #70-231-905.
- b. Three meter stand (1 required) shall be Duraform catalog #70-231-300 and included with eight (8) bronze deck anchors, Duraform catalog #70-231-905.

- H. Diving boards (2 required) shall be an aluminum extrusion type springboard. The diving boards shall be a Maxi-Flex Model "B" diving board as manufactured by Duraflex International, Inc., model #66-231-330 or approved equal. The diving board shall be 16 ft long and 19-5/8 inches wide. The top surface shall be finished with three coats combined with a mixture of sand and white aluminum oxide to affect the non-skid surface with 200 perforations.

- I. Surge tank access hatch (3 required) shall be provided as shown on the drawings. The access hatch shall be a single door 3 ft.-2 in. x 2 ft.6 in with 1" fillable pan to receive ceramic tile and grout or concrete fill to match the surrounding deck. The frame shall be ¼ inch extruded aluminum with built in neoprene cushion and continuous anchor flange. Door shall be ¼" aluminum plate reinforced with aluminum stiffeners as required. Door shall be equipped with heavy continuous stainless steel hinges and shall have compression spring operators for easy operation. Door shall open to 90 degrees and lock automatically in that position. Door shall be built to withstand a live load of 150 lbs. per square foot and equipped with a continuous Type 316L stainless steel hinge, tubular type, and an automatic hold open arm with release handle. All hardware is to be type 316L, 18-8, stainless steel. A flush lift handle and a snap lock with removable key wrench shall be provided. Factory finish shall be mill finish with bituminous coating applied to the exterior of the frame. The access door shall be Type TER-3 single leaf pan type door as manufactured by the Bilco Company.

- J. Surge tank and backwash catch basin ladder rungs shall be ½ inch Grade 60 steel encased with co-polymer polypropylene plastic as manufactured by M.A. Industries, Inc, phone 770-487-7761.

K. Pool Lift

1. Pool lift (2 required) shall be a battery powered handicap lift with footrest assembly. Lift shall comply with the Americans with Disabilities Act Access Guidelines (ADAAG), be capable of lifting 500 lbs, and shall include a stainless steel anchor socket, cover, spanner key, and a seat belt assembly. The following accessories shall also be provided: caddy, arm rest assembly, lift cover, stability vest, extra battery, wireless controls, and spineboard attachment. All stainless steel components shall be 304L. Lift to be the Traveler BP 500 model #27610, manufactured by Spectrum Products, or approved equal. Contractor to confirm pool lift fits on pool perimeter and operates correctly.
- L. Provided a ship's ladder in the size and shape shown on the drawings. Ladder shall be aluminum with aluminum stiffeners if required by OSHA. CONTRACTOR shall provide ladder to general contractor for installation. Refer to the Architect.

2.12 LOOSE EQUIPMENT

- A. Competition floating lane ropes shall be as shown on the drawings and described in these specifications. Floating lane ropes shall be a non-turbulent type with wave quelling floats and 3/16" stainless steel coated cable. Floats shall be injection-molded polyethylene. Colors to alternate the length of the pool with a contrasting solid color for the final 15 feet (competition pool) /16 feet 5 inches (training pool) (Architect/Owner to select colors). All floating lane ropes shall be provided as completely assembled and installed with take up reel, type 304 stainless steel spring and cable lock, hooks, and wrench. 5/8" wrench shall be made of a forged steel shaft with a polished chrome finish. The take up reel shall be constructed of type 304 stainless steel. The spool shall be a bronze nickel-plated casting with a nylon sleeve. Floating lane ropes shall be similar to Competitor Swim Products, Competitor Gold Medal 6" Racing Lanes, Kiefer Advantage II (6") Racing Lanes, or Anti-Wave Maximum (6") Racing Lanes, pre-assembled and sized to fit the length of the pool. Provide Competitor lane rope extension hooks as detailed on the drawings complete with protective sleeve. Floating lane ropes with disconnects for shorter distance is acceptable. Provide contrasting disks located 15 meters from each end to meet resurfacing requirement. This requirement shall be met for each possible course length.

Quantities:

| | |
|---------------------------------------|---|
| Competition Pool: (6" lane floats) | Provide 11 at 25 yards Provide 9 disconnects to convert yard length ropes to meters Provide 2 additional extension hooks Provide one spare floating lane rope that can accommodate all race courses (disconnects are acceptable) |
| Training Pool: (4" lane floats) | Provide 2 at 25 meters |

- A. Water polo floating ropes shall be as shown on the drawings and described in these specifications. Floating ropes shall be a non-turbulent type with wave quelling floats and 3/16" stainless steel coated cable. Floats shall be injection-molded polyethylene. All floating ropes shall be provided as completely assembled and installed with take up reel, type 304 stainless steel spring and cable lock, hooks, and wrench. Water polo floating ropes shall be pre-assembled and sized to fit the length of the water polo course. Provide extension hooks as detailed on the drawings complete with protective sleeve. Floats shall be colored per NCAA and FINA guidelines for each water polo course as shown on the drawings and listed below. Water polo floating ropes shall be similar to Competitor Swim Products Water Polo Rink, Anti-Wave Water Polo Course Ropes, Kiefer Advantage Water Polo Course Markings, or approved equal.

Colors:

| | |
|--------------|--------|
| Goal Line | White |
| 2 Meter Line | Red |
| 5 Meter Line | Yellow |

Half Distance Line White

Quantities:

Competition Pool: Provide (2) boundary ropes for FINA/NCAA water polo field of play
Provide four (4) goal tether ropes with 4" white disks for each goal
with a FINA/NCAA field of play. Two (2) tether ropes for each goal
shall include 2 meters long x 1.08 meters wide area of solid red
disks to identify the re-entry area per FINA WP1.2 field of play
diagram.

- B. Water polo ejection board shall be shown on the drawings and described in these specifications. The ejection board shall be capable of displaying both teams' cap numbers, the number of ejections per cap number, and each team's remaining time outs. The board shall be ¼" aluminum material with attached acrylic tracks that fit 2" high quick change letters and colored circles. The ejection board shall be securely attached to a wall or attached to a moveable stand. The ejection board shall be custom made by All Star Record Boards, call (814) 725-5834, or approved equal.
- C. Backstroke flags:
1. Backstroke flags shall be made of Nylon material, triangular in shape (12" wide x 17" long), and alternating in color, and sewn onto a Nylon tape. Additional tape shall be provided at both ends for fastening to the stanchions. Submit samples for review and approval. Equipment shall be Kiefer Nylon Backstroke Flags, #600120, or approved equal.
- D. Recall rope shall be 1/2 inch yellow polypropylene rope complete with weight rings and two quick snap connectors made of chrome-plated brass. The rope shall consist of a neco plate constructed of soft aluminum that is crimped and used to connect the two pieces of rope to form the required loops. Recall rope shall be Recreonics, catalog no. 92-968 for a 10 lane pool or custom length.
- E. Lane rope storage reel shall be fabricated from two powder-coated enclosed aluminum wheels joined together by a 1-1/4 inch aluminum axle. This unit must ride easily on four 6" stainless steel casters with individual brakes. The reel shall have a collapsible tow handle for safe movability. The storage reel should be able to hold 902' of 4" lane ropes or 492' of 6" lane ropes. The CONTRACTOR is responsible for assembly. The correct number of storage reels shall be provided to store all lane line markers. Lane line storage reel to be Competitor Swim Products Elite Stor Lane Reel, Catalog #200 850 with Competitor storage reel cover, catalog #200 861, or approved equal.
- F. Lifeline shall be 3/4 inch blue and white polyethylene rope with floats that are 5 inch diameter by 9 inch long. Floats to be spaced on five foot centers. All metallic rope hooks shall be stainless steel. Provide lifeline at five foot break between shallow and deep water as shown on the drawings. Lifeline to be equal to Recreonics no. 14-381.BW or Lincoln Aquatics 44-115 safety line rope, Recreonics no. 14-381 or Lincoln Aquatics 44-190 locking 5" x 9" floats, and Recreonics no. 14-456 or Lincoln Aquatics 44-125 rope end hooks.
- G. T-wrench for operation of valve extensions shall be fabricated of ¾" diameter SCH 40 stainless steel pipe. The T-wrench shall be 4'-0" in length with a 24" long welded "T" handle. The wrench shall be fitted with a ¾" square stainless steel male end, 1" in length, for operation of valve extensions at the surge tank. Two complete T-wrenches shall be provided.

2.13 MAINTENANCE EQUIPMENT

- A. The following items are to be supplied by the CONTRACTOR unless otherwise noted. All proprietary names are to designate performance only. Equal products will be accepted.

1. Wall brush (3 required) - Brush backing shall be a flexible polyethylene material with five (5) rows of nylon bristles. Pool brush holder shall be permanent mold cast aluminum with hydrofoil flap. Holder shall have stainless steel screws to facilitate brush changes. Handle bracket shall be quick detachable mount to fit standard 1 ¼ or 1 ½ inch diameter handles. Brush to be Recreonics no. 10-135, Lincoln Aquatics 31-020, or approved equal.
2. Skimming net (3 required) - Skimmer head shall consist of one-piece molded plastic frame with a reinforced, integral handle bracket suitable for quick attachment to a standard 1¼ or 1 ½ inch diameter handle using bolts and wing nut. The standard nylon net shall be attached to the frame using the groove and spline method. Net depth shall be 4 inches minimum in the center. Skimmer net shall be manufactured by Skimlife No. SS8, or approved equal.
3. Telescopic Poles (3 required) - Cleaning tool handle shall be of the telescopic design and fabricated from corrosion resistant, high-quality anodized aluminum. Poles shall be fully adjustable, to desired length, with a simple twist of a cyclac threaded locking device. Poles shall consist of a 1 inch tube fitted inside a 1¼ inch tube and be adjustable from a range of 8 ft. to 16 ft. Handle shall be adjustable from 8 ft. to approximately 16 ft. having a threaded bushing type clamp to lock handle at desired position. Poles shall be manufactured by Pool King, or approved equal.
4. Portable Vacuum Poles
 - a. Telescopic poles fiberglass poles (3 required) - Vacuum head attachment poles are to have a super-tough 1¼ inch fiberglass handle. Poles are to be 8 ft. each, totaling a 24 ft. length for vacuum head attachment. Poles are to be Recreonics No. 10-370 with quick change adapter Recreonics no. 10-374 or approved equal.
5. Test Kits
 - a. Provide two (2) test kits FOR EACH MECHANICAL ROOM
 - 1) The first test kit shall feature liquid reagents, color comparator, waterproof instructions and treatment charts, chemistry guide and water gram. Test kit to have the ability to test for free and total chlorine (0.5 – 5.0 ppm), bromine (1-10 ppm), pH (7.0 – 8.0), acid and base demand, total alkalinity, calcium hardness and cyanuric acid. Test kit shall be Taylor Complete 2005 test kit, or approved equal.
 - 2) The second test kit shall be photometric and utilize tablet reagents for stability that will allow accurate measurement of free and total chlorine (0-10 ppm), bromine, pH, alkalinity, calcium hardness, and cyanuric acid. The test kit shall have solid-state digital electronics and built-in filters. The test kit shall be direct-reading with automatic blank settings, automatic power cut-off, and store the last 10 results in nonvolatile memory. Test kit shall be a Pooltest 6 system based on the Palintest system of water analysis. Provide SPH 006D Pooltest 6 - Hard Carry Case Kit and SPC 006 Check Standard or AquaPRO 6 Test Kit manufactured by Orbeco-Hellige Inc. and Reference Standard Kit (LP275680).
6. Vacuum Cleaner
 - a. Vacuum cleaner (filtered water return to pool) - (1 required) to be complete with a 36 inch dual manifold head with 75 feet of 1-1/2 inch floating hose. Hose to be Recreonics, catalog no. 10-429, Lincoln Aquatics no. 29-065 or approved equal. 24 ft. stainless steel pole shall be available for attachment. The portable cartridge vacuum cleaner system shall include a 155 square foot T-316 stainless steel up-flow single cartridge filter, a 1 HP self-priming thermoplastic self-priming pump 1-1/2 inch suction and discharge connection and 110 cubic inch strainer capacity. Cartridge shall be Harmsco no. ST/155 or approved equal. The

system shall be provided with one spare cartridge filter. The pump motor shall be 115 volt single phase, 60-cycle, open-drip proof and shall be UL and NSF listed. The pump motor shall be provided with a 120-volt Hubbell switch, weather proof switch cover, in-line pre-wired GFCI and a 100' power cord. The cord shall be wired to a 20 amp, 115/230 volt switch which shall be mounted on pump motor. All interconnecting pipe and fittings shall be schedule 40 PVC. The entire assembly shall be bolted to a T-316 stainless steel cart and shall have pneumatic wheels with grease fittings and roller bearing hubs. Unit to be Recreonics, catalog no. 10-806, Lincoln Aquatics no. 27-010, or approved equal. Accessories shall include a 1-1/2 inch x 25 ft. discharge hose with stainless steel hose clamp. Hose to be manufactured by Quaker Plastic Corporation no. QT-131, or approved equal.

7. Robotic Pool Cleaner

a. DuraMax Robotic Pool Cleaner

1) Provide one (1) dual motor driven automatic swimming pool vacuum device. Cleaner weighs 37 lbs and has internal water-cooled brushless drive motor with automatic program to clean the pool floor and walls, travelling 1 ft per second, scrubbing pool surfaces with onboard rubber brushes. Separate internal oil-cooled, water-cooled, brushless pump motor filters 4,800 GPH, vacuuming a 2 ft wide path using two offset 7½ square inch suction inlets underneath, filtering fine debris <10 microns small and solids as large as 1½ inch into an internal reusable filter bag. Solid ½" 316 stainless steel axles extend the length of the cleaner connecting to a commercial-grade drive-train with Kevlar reinforced drive belts. Stainless steel reinforced side plates are capped with soft gray tracking wheels for durability and corner and curve tracking agility. Unit complete with remote control, air sensor, UltraKart Junior, 120 ft cord, set of SK3017BL deep clean super brushes (for most surfaces) , filter bag, digital timer, power supply with 24 volt transformer, operator manual. Requires 110 volt GFCI receptacle onsite, consumes 3 amps electricity. The pool cleaner shall be a DuraMax R/C as manufactured by Aqua Products, Inc., or approved equal.

2) Provide one (1) dual motor driven automatic swimming pool vacuum device. Cleaner weighs 45 lbs and has internal water-cooled brushless drive motor with automatic program to clean the pool floor and walls, travelling 1¼ ft per second, scrubbing pool surfaces with onboard rubber brushes. Two separate internal oil-cooled, water-cooled, brushless pump motors filter 9,600 GPH, vacuuming a 2 ft wide path using two offset 7½ square inch suction inlets underneath, filtering fine debris <10 microns small and solids as large as 1½ inch into an internal reusable filter bag. Solid ½" 316 stainless steel axles extend the length of the cleaner connecting to a commercial-grade drive-train with Kevlar reinforced drive belts. Stainless steel reinforced side plates are capped with soft gray tracking wheels for durability and corner and curve tracking agility. Unit complete with remote control, air sensor, UltraKart Junior, 120 ft cord, set of SK3016BL7 deep clean super brushes (for most surfaces), filter bag, digital timer, power supply with 24 volt transformer, 1 hour cleaning cycle delay option, operator manual. Requires 110 volt GFCI receptacle onsite, consumes 5 amps electricity. The pool cleaner shall be a DuraMax Duo Junior as manufactured by Aqua Products, Inc., or approved equal. Include with 120 ft cord.

8. Stainless Steel Cleaner - Provide a stainless steel cleaner. The cleaner shall comprise of one (1) gallon of organic passivation solution. It shall be complete with instructions for proper maintenance of stainless steel surfaces and material safety data sheets for the passivation solution. The cleaner shall be the Spectra-Clean System 2 as manufactured by Spectrum Products. Product to be applied with 3M scouring pad, or equivalent.

2.14 SAFETY EQUIPMENT

- A. The following items are to be supplied by the CONTRACTOR unless otherwise noted. All proprietary names are to designate performance only. Equal products will be accepted.
1. Ring buoy and extension rope (5 required) – Buoy shall be 24 inch diameter vinyl clad PVC foam with a metal ring molded inside. Buoy shall have a 3/8 inch polyethylene rope attached to it at four points and be a minimum 60 feet in length. Preserver shall be U.S.C.G. approved. Buoy and rope to be mounted at each lifeguard chair on hooks. Ring buoy to be manufactured by Cal-June no. G-24-WH or approved equal. Throw rope to be Recreonics no. 12-261, Lincoln Aquatics No. 42-050, or approved equal.
 2. Life hook and fiberglass pole (5 required) - Life hook shall be an anodized aluminum 3/8 inch OD "shepherd's crook" with a 1-1/8-inch OD handle attachment suitable for a 1¼-inch 16 ft. fiberglass extension pole. Each life hook shall be provided with a separate 16 ft pole. Hook shall be of looped construction. Each pole to be provided with a set of spring type stainless steel pole clamps for mounting on each lifeguard chair. Life hook shall be manufactured by Rainbow no. 153, or approved equal. Pole clamps shall be Recreonics no. 10-353, or approved equal, and fiberglass poles shall be equal to Recreonics no. 10-372.
 3. Spineboards (1 required) - Spineboard shall be 72" long x 20" wide, constructed of 100% virgin high density polyethylene. The design shall provide stiffness and torsional rigidity while remaining lightweight. The spineboard shall accommodate up to 500 lbs and shall feature customizable buoyancy that allows users to adjust the buoyancy by inserting polyethylene foam rods (supplied with the spineboard). There shall be (10) handholds around the perimeter of the board. The spineboard shall be supplied with one (1) 2-piece head immobilizer, one (1) head strap, four (4) body straps, one (1) head immobilizer with head bed, and two (2) flotation rods. The spineboard shall be CJ Rescue 6 package as manufactured by CJ spineboard at 1-206-824-8886 or approved equal. The CONTRACTOR shall provide one (1) set of heavy duty stainless steel utility hooks per spineboard for storing the spineboard at a convenient and readily accessible location near the pool (Recreonics catalog no. 10-362).
 4. First aid kit (2 required) - First aid kit shall be a 24 unit kit per American Red Cross standards as manufactured by Swift First Aid, or approved equal.
 5. Rescue tube (10 required) - Provide one rescue tube for each lifeguard chair. Rescue tube to be Recreonics No. 12-303, or approved equal.
 6. Safety eyewash station (2 required) - Safety eyewash station shall be a self-contained system in which eyewash bottles are securely positioned in a portable holder. Eyewash bottles shall be 32 ounces and easily removable from case, and shall contain a sterile, saline solution with the ability to neutralize a varying quantity acids or caustics. Eyewash stations shall be equipped with a double back screw and holes for easy mounting in location to be determined by the Architect. Stations shall be Recreonics 12-033, Lincoln Aquatics 49-026, or approved equal.
 7. Safety eyeglasses - Provided a safety eyeglass dispenser station containing ten (10) pairs of safety glasses. Eyeglasses shall be ANSI/OSHA accepted, and be equal to Lab Safety Supply Inc. (1-800-356-0783) no. WQ-14740B.
 8. Bag Valve Masks – Provide two (2) bag valve mask assistant resuscitation systems, one size Adult (1500ml tidal volume) and one size Infant/Child (450ml tidal volume). Product shall be a latex free disposable bag mask unit with support strap, transparent patient valve, and textured surface to eliminate slipping. Integral swivel valve, available with a closed reservoir system. Standard pack includes resuscitator, oxygen reservoir and a transparent bag for storage. Bag Valve Masks shall be Ambu SPUR II, or approved equal.

2.15 THERMOMETERS

- A. The following items are to be supplied by the CONTRACTOR unless otherwise noted. All proprietary names are to designate performance only. Equal products will be accepted.
1. Portable thermometer (3 required) shall be a molded ABS plastic tube body type with the ability to measure temperature in both degrees Fahrenheit and Celsius. A 3 ft. polyethylene cord is to be attached to thermometer. Thermometer is to be manufactured by Pac-Fab/Rainbow no. R141036 or approved equal.
 2. Inline thermometer to be near the heating loop and shall have a 9 inch adjustable angle with a minimum 6 inch stem. There shall be a minimum of two (2) thermometers per loop, and must have ability to read temperature in both degrees Fahrenheit and Celsius. Thermometers are to be Recreonics no. 32-702, Lincoln Aquatics no. 21-125, or approved equal.

2.16 SWIMMING POOL FINISHES

A. Paint

1. The interior surfaces of the gutter trough pit shall be coated with a high build epoxy. The color shall be white or an approved light color. The color of the 15-meter resurfacing marker shall be a contrasting color to the pool deck; final color selection by Architect.
2. Coating shall be a low VOC compliant polyamidoamine epoxy suitable for chlorinated water below 3.2 ppm for installation on concrete surfaces. CONTRACTOR shall provide on-site technical services and approval from the coating manufacturer prior to application and during the coating application. Coating shall be Tnemec Series 161HS, Induron Perma-Clean II Semi-Gloss or approved equal. Color shall be white.
3. Surface Preparation
 - a. Cast-In-Place Concrete
 - 1) Allow concrete to cure a minimum of 28 days at 60 deg. F. Brush-off pool interior surfaces, then blast clean to remove laitance and weak surface concrete to produce an anchor profile similar to medium grade sandpaper referencing SSPC-SP13/NACE 6, ICRI-CSP 2-4 Surface Preparation of Concrete. Blasting shall open up surface voids, holes and irregularities. No holes or holidays in the paint membrane will be allowed. Fill with an approved grout or Tnemec Series 215 Surfacing Epoxy, or Induron EFS707 Epoxy Surfacer and Filler, any hole or irregularity that cannot be satisfactorily painted. Do not entirely remove the surface or completely expose underlying aggregate. After blasting, neutralize concrete with a solution of 2 cups aqua ammonia per 5 gallons of water. Flush with clean water and allow to thoroughly dry.
 - b. Pneumatically Applied Concrete
 - 1) Allow concrete to cure a minimum of 28 days at 60 deg. F. Prior to applying paint to a pneumatically applied concrete surface, a brown coat plaster leveling surface shall be applied. The pneumatically applied concrete surface shall be prepared for the application of the brown coat by removing all loose materials, laitance, minerals, and chemical traces. If a brown coat has been utilized, provide a clean, firm surface or anchor profile similar to a medium grade sandpaper, suitable for the application of paint. No holes or holidays in the paint surface will be allowed. Fill with an approved grout or Tnemec Series 215 Surfacing Epoxy, or Induron EFS707 Epoxy Surfacer and Filler, any hole or irregularity that cannot be satisfactorily painted.
4. Application Procedures

- a. Before applying any material, measure and record the temperature and relative humidity. Apply only if temperature is above 55 deg. F. and at no lower temperature than 5 deg. F. above the dew point. Do not apply when the relative humidity is greater than 85%. If possible, plan the painting schedule so that all painting is done in the coolest part of the day. Provide proper ventilation so that paint fumes do not become concentrated.
5. Application of the Primer
 - a. After the pool surface has been thoroughly dried and cleaned the primer coat can be applied. Surface spreading rate shall be observed as not to exceed the recommended manufacturer's rate of application. The primer will be applied at a minimum rate of 200 SF per gallon and shall conform to local VOC requirements. A good heavy coat shall be applied. A rough or porous concrete pool will require more paint than recommended. On particularly rough surfaces two coats are recommended in order to provide a smooth, uniform finish. Note: Any marks or irregularities that show through the primer will also be apparent when the finish coat is applied.
6. Application will be made by brush, roll, lambs wool applicator, or spray. When the finish coat is to be a color other than white the primer will be tinted.
7. Application of the Finish
 - a. After the primer is dry enough to walk on without removing or marking surface, apply the finish coat(s) in accordance with the manufacturer's instructions. Application shall be done by the use of a brush, roller, lamb's wool applicator, or spray methods at a rate of 150-250 SF per gallon. Allow a minimum of 5 hours (at 75 deg. F) drying time between coats. Two coats of finish paint are recommended to improve upon general appearance of pool shell. Allow 7 days curing (at 77 deg. F.) before filling the pool.
8. Final paint coating shall be allowed to dry a minimum of 7 days at 35 degree Fahrenheit or above, before filling the pool.
- B. Pool Cementitious Finish – Reference specification section 131104, Swimming Pool Cementitious Finish.
- C. Pool Tile – Reference specification section 131103, Swimming Pool Tile.

2.17 WATERPROOFING

- A. Products
 1. Interior surfaces of Surge Tank and Backwash Pit with NO additional finishes: Apply two (2) coats of BB White from Vandex, Modify or Megamix I from Xypex, or Planiseal 88 from Mapei, directly to surface of surge tank and backwash pit.
- B. Surface Preparation
 1. Surface shall be structurally sound and free of any foreign substances and debris that could reduce or impair adhesion. Surfaces shall be roughened by sand blasting, water jetting, shot blasting, scarifying, or grinding. Surface defects or holes shall be patched per manufacturer's recommendations.
- C. Application
 1. Do not apply materials under conditions where the ambient air temperature is less than 40 degrees Fahrenheit, or to a frozen substrate.

2. All mixing of products, quantities and application procedures shall be done in accordance with the manufacturer's recommendations.

2.18 SEALANTS

- A. Provide sealed expansion joints as shown on the pool and pool structural drawings or noted on the Contractor's construction/expansion joint layout, and as required. Expansion joints shall be constructed and sealed as indicated and in accordance with the manufacturer's recommendation. Sealant to be manufactured by LATICRETE International, Inc., Mapei, or Deck-O-Seal.
 1. For submerged joints:
 - a. Latasil, one component, neutral cure, high performance, 100% silicone sealant in the color(s) as selected. Shall be used in conjunction with Latasil 9118 Primer per manufacturer's recommendations.
 - b. Mapesil T, 100% silicone sealant in the color(s) as selected.
 2. For joints behind the coping, or other horizontal deck joints:
 - a. Deck-O-Seal, two component (gun-grade or pourable, self-leveling), high resilience, non sag, non flowing, polysulfide-based sealing compound in the color(s) as selected. Shall be used in conjunction with P/G Primer per manufacturer's recommendations.
- B. Material Storage
 1. All materials are to be stored in the original unopened factory containers in a cool dry location 60 to 80 degrees F. Protected from the elements and the hazards of construction. Open only as many containers as can be used in any particular period.
- C. Joint Preparation
 1. Clean the joints of all deleterious material, to sound, clean and dry substrate.
 2. Joint is to be formed or filled with an approved, resilient, non-asphaltic, closed cell, polyethylene joint filler material down to firm substrate. Allow space at the top of the joint for the installation of approved closed cell polyethylene backer rod and install same to the required depth below the surface of the slab to control the depth of the sealant bead to within manufacturer requirements.
- D. Surface Preparation
 1. Concrete surfaces to receive sealant must be fully cured, clean, dry and free of dirt, dust and any deleterious material that might compromise the adhesion and performance of the sealant. Curing aids, form release agents and joint former residue must be completely removed, if necessary by sand blasting and/or grinding. Loose dust must be brushed off.
 2. Prime all surfaces to receive Latasil sealant with Latasil 9118 Primer prior to sealant application, and surfaces to receive Deck-O-Seal sealant with P/G Primer prior to application.
- E. Application
 1. Apply sealant in accordance with the manufacturer's recommendations.

2. Tool the joint immediately after application to insure a firm, intimate contact with the joint interface.
3. Remove excess sealant and smears from adjacent surfaces with Xylol or Toluol before sealant cures.
4. After the sealant has fully cured (generally a minimum period of five days at 72 degrees and 50% humidity), paint the surface of the sealant with a chlorine resistant chlorinated rubber or equivalent pool paint, such as Ramuc, in a compatible color as selected by the Architect.
NOTE: Latasil cannot be painted.

2.19 AQUATIC FACILITY MANAGEMENT APPLICATION

Contractor shall provide a one-year license for a web-based digital application for managing the aquatic facility. Digital application shall include fully customizable check lists, pool testing documentation with NSPF dosage calculations and MAHC references, MAHC compliant lifeguard in service documentation with the ability to link to employee tracking module, pool closure forms, and incident reports. Web-based digital application shall be Facility Manager (contact Johnathan Nies at 303-323-8527 or online at <https://nl290.infusionsoft.app/app/storeFront/showStoreFront>) or approved equal.

- A. Contractor shall have web-based digital application representative provide one-hour of online training.
- B. Contractor shall set up web-based digital application in Owners name 30 days prior to facility opening.

2.20 UNDERWATER LIGHTS

- A. Underwater lights shall be equivalent to 500 watts of incandescent light. Underwater lights shall be UL listed and in the quantities shown and as detailed in the construction drawings and as described in these specifications. Coordinate for proper installation. Refer to the drawings for quantities and locations.
- B. The pool underwater lights shall be 120VAC, 55 watts LED-type, and equivalent to 500 watts of incandescent light. Fixture housing shall be stainless steel construction with minimum wall thickness of 0.020 inch per UL 676 underwater pool lighting standard. The niche shall be stainless steel with cast brass mounting ring or PVC plastic with stainless steel mounting ring. Brass construction pressure grounding lug on interior and exterior services. Lens shall be 8-3/8 diameter clear tempered heat resistant glass. Gasket to be single-piece "U" shaped santoprene or silicone. Fasteners shall be silicon-bronze or stainless steel. The light fixture shall be supplied with a #16-3 STW (120V) submersible cord with ground wire positively grounded inside the fixture. Cord entrance shall be a watertight seal and epoxy encapsulated. Light fixture to be IntelliBrite 5g White LED pool light series by Pentair Commercial Pool and Aquatics or approved equal. Underwater lights shall be provided with cord length as required to allow for deck relamping of all fixtures.
- C. Junction boxes shall be provided in the quantities required and shall be located at least 8" above the pool coping and 5' from the pool edge. Refer to the Electrical drawings. Cord length shall be sufficient to run from fixture to the junction box with sufficient cable in the niche to re-lamp the fixture on the deck. Junction boxes shall be furnished by the Contractor and installed by Electrical.

2.21 POOL COVERS

- A. The swimming pool cover system shall be the standard catalogued product of a company regularly engaged in the manufacture of such products. Alternate swimming pool cover systems shall not be considered unless equal to the specified product and must be submitted for approval not less than

ten (10) days prior to bid date. Submittal data must include complete documentation relating to all the specified features and include manufacturer's sales literature, specification sheets, energy conservation audit, installation/maintenance manuals and engineering drawings.

- B. The swimming pool cover system shall be of the energy conservation type. The covers shall be supplied in panel sections, allowing for ease of storage, and ease of installation and removal. The cover panel materials shall withstand the commercial aquatic facility's environment. Panels shall receive edging materials to strengthen the panel and to allow for deployment and retrieval without damaging the panel's main body materials. All materials shall be ultraviolet stabilized to ensure long life. The cover panels shall be reversible, allowing for the panels to be rotated, using both sides and end to end, every other year, supporting additional panel life. Warning labels shall be affixed in four places to both sides of the panel and shall instruct in the panels proper use and warn patrons of hazards associated with covered swimming pools. Cover panel systems shall be supplied with a protector, for use when panels are not deployed.
- C. Basis of design: The swimming pool cover system and its accessory items shall be manufactured by Spectrum Products, T- Star Enterprises, or approved equal.
- D. Cover Material
 - 1. Material shall be woven, twelve by twelve count per inch, high-density polyethylene, ultraviolet stabilized film fabric, flame laminated to both sides of a 1/8-inch thick, closed cell, medium density, white, polyethylene foam. The woven polyethylene film fabric shall be coated on the exposed sides with an ultraviolet stabilized, chemically resistant polyethylene coating. The combination of film, foam and woven components shall be non-toxic, non-absorbent, non-permeable and buoyant. Color shall be blue on upper surface and on under surface. In addition to the above, cover shall meet the following requirements:
 - 2. Cover Design Criteria
 - a. Cover panels shall be divided into widths suitable for convenient daily use (removal and deployment), totally covering the surface of the swimming pool without gaps or overlaps. Cover panels shall be compatible for use with storage reel(s) and not exceed a width equal to one foot less than the length of the storage reel winding tube on which it is to be stored.
 - 3. Edging
 - a. Protective-reinforcement edging shall be installed along ends and sides of each panel. A weighted non-metallic/non-corroding material shall be sewn into the panel protective edging. The weighted edge shall be flat and shall conform to the shape of the cover. Cover end edges shall be reinforced with a double layer of polyethylene-coated film fabric. The end edging shall be designed, in such a manner as, to prevent panels from diving when they are being pulled across the surface of the swimming pool. The encapsulated weighted edging shall be wrapped around the cover corners. The entire corner construction shall be reinforced with a 1/8-inch thick load dispersion plate. Both ends of each cover panel shall be equipped with no less than three (3) non-corrosive/metallic grommets and quick-release loops for easy connection to a storage reel or to the next cover panel.
 - 4. Sewing
 - a. All sewing shall be double locking chain stitch, using ultraviolet stabilized, chemically resistant, 100% polyester thread. Main body seams shall be double overlap parallel double chain lock stitched. No butt, welded, glued or heat-sealed seams will be employed. All sewing shall be accomplished with computer-controlled machines, synchronizing speed with stitch length to assure uniformity and strength.

5. Warning Labels

- a. Warning labels consistent with the recommendations of the Federal Consumer Protection Agency shall be permanently affixed to each end of each cover panel and to the sides of perimeter panels on both side of the panel.

E. Products

- 1. The pool cover system shall be the Marias II for standard rectangular swimming pools model #500013 by Spectrum Products, the Energy Saver by T-Star Enterprises, or approved equal.
- 2. The Portable Storage Reel Assembly shall be the Bitterroot II 15-foot double tube storage reel model #50130 or approved equal.

2.22 POOL HEATERS

- A. The pool heater for the competition pool shall have an input rating of 1,990,000 Btu/hr.
- B. The pool heater for the training pool shall have an input rating of 800,000 Btu/hr.
- C. The pool heater for the dive pool (Alt. #2) shall have an input rating of 800,000 Btu/hr.
 - 1. Basis of design: the pool heater for the pools shall be manufactured by LOCHINVAR, model COPPER-FIN II Commercial (2) Model CPN 0992.
 - a. Competition Pool = (2) Model CPN 0992
 - b. Training Pool = (1) Model CPN 0992
 - c. Dive Pool = (1) Model CPN 0992
- D. The pool heater shall be orificed for operation on (Natural Gas).
- E. The water containing section shall be of a "Fin Tube" design, with straight cupro-nickel tubes having extruded integral fins spaced seven (7) fins per inch. The tubes shall terminate into a one piece, glass lined, cast iron header. There shall be no bolts, gasket of "O" rings in the head configuration. There shall be access to the front header of the heat exchanger for the purposes of inspection, cleaning or repair. The heat exchanger shall be mounted in a stress free jacket assembly in order to provide a "free floating design" able to withstand the effect of thermal shock. The pool heater shall bear the ASME "H" stamp for 160 PSI working pressure and shall be National Board listed.
- F. The combustion chamber shall be sealed and lined with Loch-Heat ceramic fiberboard insulation. High temperature stainless steel burners of a premix design shall be used. A fan assisted combustion process shall precisely control the fuel/air mixture for maximum efficiency. Combustion air blowers shall operate for a pre-purge period before burner ignition and a post-purge period burner operation.
- G. The pool heater shall be constructed with a heavy gauge steel jacket assembly, galvanized on both sides. All exterior surfaces shall be finished in a 3-coat acrylic enamel finish.
- H. The pool heater shall be certified by the American Gas Association Laboratories. The pool heater shall operate at a thermal efficiency of 82% and comply with the energy efficiency requirements of the latest edition of the ASHRAE Standard 90.1-1999.

- I. The pool heater shall have a factory supplied pumped bypass assembly to insure proper operation without condensation. The bypass assembly shall include a sealed all bronze pump. The bypass assembly shall be constructed of schedule 80 CPVC piping with brass inserts and an automatic three-way valve.
- J. Standard operating controls shall include an electronic temperature control and immersion limit controls for pool water temperature, a heater safety high limit and auxiliary heater limit control. All controls shall be factory installed within the weatherproof enclosure and include a lighted on/off main power switch and indicating lights for call for heat and flame failure.
- K. The pool heater shall use a hot surface ignition system with full flame monitoring capability. Multiple main gas valves with redundant valve seats and built in low gas pressure regulators shall be supplied as standard. Additional standard controls shall include a blocked flue pressure switch, a low air pressure switch for each fan, a 24 VAC transformer for the control circuit and an ASME temperature and pressure relief valve. All components shall have multi-pin plug in type connectors to ease service, troubleshooting and lower removal and replacement cost. Proper operation of the burners, all controls and the heat exchanger shall be verified with a full factory fire test prior to shipping. A quality test report shall be supplied.
- L. The pool heater shall be approved for indoor installation. The pool heater shall be approved for conventional venting (see mechanical detail) and shall be classified Category I, negative draft, and non-condensing, using a type "B" double wall vent material.
- M. The pool heater shall have an independent laboratory rating for Oxides of Nitrogen (NO_x) of less than 20 ppm corrected to 3% O₂.
- N. The Contractor shall provide the pool water heating system. Heating system to include all piping, heaters, booster pumps, controls, gauges, thermostats, control valves and wiring required to draw water from the recirculation piping, heat the water and return it back to the recirculation piping. The Contractor shall interlock pool heating system with pool recirculation pumps.
- O. Contractor shall have pool heater manufacturer representative on site to start and adjust pool heater. Copies of the startup report shall be sent to the Manufacturer and Architect/Engineer prior to final site observation and shall include the following information for each pool heater:
 - 3. Temperature settings
 - 4. Inlet Gas Supply Pressure
 - 5. Manifold Gas Pressure
 - 6. Air Pressure
 - 7. Gas Piping Configuration
 - 8. Venting Configuration
 - 9. Booster pump interlocked with recirculation pump
 - 10. Separate circuits for pump and heater
 - 11. Flow switch installed
 - 12. A component and integrated check shall be made of all controls. Factory tests do not substitute for this test.

- P. Provide and install the Stack Frame for the Pool Heaters. Basis of design Lochinvar Pre-assembled welded construction stacked frame- Model CP 992 - (2) required.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS, INSPECTION AND PREPARATION

- A. Carefully examine all of the contract documents for requirements that affect the work of this section. Prior to starting any work, notify the General Contractor of defects requiring correction. Do not start work until conditions are satisfactory.
- B. Verify that all work by others, related to this section, has been completed. This includes all earthwork, concrete work, and mechanical, electrical and plumbing connections.
- C. Protect all materials and work completed by others from damage while completing the work in this section.

3.2 FIELD MEASUREMENTS

- A. Verify benchmark and pool location prior to layout.
- B. If field measurements differ from the construction drawing dimensions, notification shall be given to the Architect prior to proceeding with work.

3.3 EXCAVATION, REINFORCING STEEL AND SWIMMING POOL PNEUMATICALLY APPLIED OR CAST-IN-PLACE CONCRETE

- A. Reference Division 31 - Earthwork
- B. Reference Division 3 - Concrete
- C. Reference Section 131102 – Swimming Pool Pneumatically Applied Concrete
- D. Reference Section 131101 – Swimming Pool Cast-In-Place Concrete

3.4 TOLERANCES FOR CONSTRUCTION OF THE POOL SHELL

- A. The completed structures shall be constructed level and to the dimensions, elevation, depths and thickness as shown on the plans.
- B. The elevation tolerance of the pool shell and gutter lip shall be plus or minus 1/8 inch.
- C. The vertical wall surface tolerance of the pool shell, for the first 36 inches from the water surface shall be plus or minus 1/4 inch from plumb measured with a 6 foot straight edge.
- D. For competitive race courses, the following pool shell tolerances shall apply:

| Course | Tolerance | Minimum | Maximum |
|----------|-----------------|------------|----------------|
| 25 Yard | + 1 3/16" /- 0" | 75' – 3/4" | 75' – 1 15/16" |
| 25 Meter | + 0.010 M | 25.02 M | 25.03 M |

1. The above dimensions include allowances for a touchpad at each end of the course. The maximum dimension includes the construction tolerance. These above tolerances also apply to courses utilizing moveable bulkhead(s).

2. The above dimensions apply to a vertical plane extending 1'-0" above and 3'-0" below the surface of the water at all points of both end walls.
- E. The CONTRACTOR shall provide the services of a registered engineer or land surveyor who shall measure and certify the elevations of the gutter lip at 10 foot centers as well as the length of each lane for each possible racing course. Courses designed with touchpads for competition shall be measured and certified with touchpads in place. Course length survey must be made with the pool filled with water between 78 and 82 degrees Fahrenheit. Forms for the lane measurements are available from USA Swimming (719-866-4578) and must be submitted by the Contractor.
- F. Ground wires or grade pins, if used, shall be installed in such a manner that they accurately outline the section of the pool shell as indicated on the plans. They shall be located at intervals sufficient to insure proper thickness throughout and shall be maintained tight. Grade pins or grounding wires shall not be permanently embedded in the pool shell.

3.5 WATER TIGHTNESS TEST

- A. This test applies to the pool(s), the surge tank(s), and the gutter system(s). The water tightness test shall be completed prior to the application of the pool finish.
- B. Water Tightness Test Procedure
 1. Preparation
 - a. Allow the concrete structure to set 28 days for curing purposes. Once the pool shell has gained sufficient strength to withstand the test load and after all the outlets have been securely sealed, the pool shall be filled with water.
 2. Fill: Fill and then isolate the pool(s), the surge tank(s), and the gutter system(s). The water tightness test shall begin after the vessel has been filled for a minimum of three (3) days. During the filling, all outlets shall be monitored for water tightness and all concrete joints shall be monitored for any visible leakage. If any visible leakage from the vessel is observed, the condition shall be corrected prior to the start of the test.
 - a. After the initial fill, all ground water shall be removed from the pool sight sump or the pool location de-watering system. This shall be completed prior to the start of the water tightness test. De-watering of the pool sight sump shall be maintained during the entire duration of the test.
 3. Evaporation/Precipitation Measurement Procedure
 - a. Fill a floating, restrained, partially filled, calibrated, open container with water and allow the container to float within the pool during the testing period. This will be used to measure evaporation and precipitation.
 4. Measurement
 - a. On a separate sheet of paper draw a sketch of the pool. Measurements shall be taken at the pool(s), the surge tank(s), and the gutter system(s). Multiple test points with averaging are recommended for vessels which will be exposed to wind. Document the separate findings on the chart below. Repeat the measurements and document every 12 hours for a total of three (3) days. The General Contractor shall check the pool(s), the surge tank(s), and the gutter system(s) for water loss with the Architect or Owner's representative every 12 hours. The Contractor(s) shall submit photo documentation of each measurement with the completed water tightness report.

| | | | | | |
|-----------------------------|----------------|-------|---------------------------|----------------|-----------------------|
| Total Allowable Water Loss: | Total Gallons: | _____ | (0.1%) x 0.001 = _____ | Allowable Loss | Pan Depth Per 24 Hrs. |
| Pool Measurements | Pool | | Gutter System | Surge Tank | Pan Measurements |
| 12 Hrs. | | | | | |
| 24 Hrs. | | | | | |
| 36 Hrs. | | | | | |
| 48 Hrs. | | | | | |
| 60 Hrs. | | | | | |
| 72 Hrs. | | | | | |

5. Total Loss = 7.481 x Structure Surface Area (SF) x Total Water Loss per Day (FT) – Evaporation per Day (FT) + Precipitation per Day (FT)

a. Day #1 =

b. Day #2 =

c. Day #3 =

6. Repair

a. The allowable leakage rate for an unlined pool structure shall not exceed 0.1 percent of the total water volume in a 24-hour period. (Example: 0.001 x 200,000 gallon pool = 200 gallons per 24 hour period.) This excludes the loss/addition of evaporation/precipitation.

7. Absorption

a. Waiting 3 days after the initial water fill will allow the concrete to absorb water and shall be sufficient to minimize the effect of absorption on the test results.

8. Evaporation

a. Evaporation shall not have a significant effect on natatoria that are completely enclosed with no air circulation during the water tightness test. However, evaporation will have a significant effect on the water level in natatoria that has air movement across the water surface or are still partially uncovered.

9. If leaks are detected, repair the vessel and make water tight in accordance with these requirements.

10. With regard to this test, the curing requirements, the final fill and the cost of the water for two (2) complete fillings shall be borne by the Owner. Any subsequent fillings or partial fillings (more than 25%) of the pool shall be by the CONTRACTOR, at its own expense.

3.6 PIPING INSTALLATION

A. General

1. Provide and erect, according to the best practices of the trade, all piping shown on the drawings and required for the complete installation of these systems. The piping shown on the drawings

shall be considered as diagrammatic in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be off set, lowered or raised as required or as directed at the site. This does not relieve the CONTRACTOR from responsibility for the proper erection of the systems or piping in every respect suitable for the work intended as described in the specifications and approved by the Architect. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods in strict accordance with the manufacturer's instructions. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the systems. Plugs of rags, wool, cotton waste or similar materials will not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment, filters or devices, and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment. All piping shall be installed to ensure noiseless circulation. All valves and specialties shall be so placed to permit easy operation and access.

B. Pipe Hangers and Supports

1. Pipes shall be adequately supported by pipe hangers and supports specified in Paragraph 2.05 Pipe, Hangers, and Valves.
2. Horizontal PVC Schedule 80 piping shall be supported in accordance with the manufacturer's recommendations for fluid temperature not exceeding 120 degree F and as listed below:

| Nominal Pipe Size (Inch) | Hanger Support Spacing (Feet) | Minimum Rod Size for Single Rod Hanger (Inch) |
|-----------------------------|----------------------------------|--|
| 1-1/4" and less | 5 | 3/8" |
| 1-1/2" to 3" | 6 | 1/2" |
| 4" to 6" | 8 | 5/8" |
| 8" to 12" | 10 | 7/8" |
| Greater than 12" | 12 | 1" |

3. Horizontal CPVC Schedule 80 piping shall be supported in accordance with the manufacturer's recommendations for fluid temperature not exceeding 140 degree F and as listed below:

| Nominal Pipe Size (Inch) | Hanger Support Spacing (Feet) | Minimum Rod Size for Single Rod Hanger (Inch) |
|-----------------------------|----------------------------------|--|
| 1/2" and less * | 4 | 3/8" |
| 3/4" to 2" | 6 | 3/8" |
| 2-1/2" to 3" | 7 | 1/2" |
| 4" to 8" | 8 | 7/8" |
| Greater than 12" | 10 | 1" |

- C. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non adhesive isolation tape.

- D. Install hangers to provide a minimum of 1 inch space between finished covering and adjacent work.
- E. Place a hanger within 12 inches of each horizontal elbow.
- F. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- G. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified in section 2.05.C.3. Trapeze hangers shall be spaced according to the smallest pipe size, or install intermediate supports according to the support spacing schedules.
- H. Do not support piping from other pipes, ductwork or other equipment that is not building structure. Do not modify building structure for hanger installation.
- I. Concrete Inserts
 - 1. Provide inserts for placement in form work before concrete is poured.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceilings, provide inserts to be flush with the slab surface.
 - 4. Provide hook rods to concrete reinforcement section for inserts carrying pipe over 4 inches.
- J. Pipe Hangers and Supports
 - 1. All piping shall be rigidly supported from the building structure by means of hanger assemblies properly selected and sized for the application in accordance with the manufacturer's recommendations and specifications.
 - 2. All piping in a service tunnel, if required shall be supported by a structure of the CONTRACTOR'S design. The structure shall be non-corrodible and shall be of a size and configuration to rigidly support all the piping as shown in the plans at a minimum spacing as shown below.
 - 3. Piping hangers shall be spaced per the below schedule and shall have hangers not more than one foot on each side of every change in direction. The piping systems shall be installed in an approved manner and shall not overload the building structural frame. The CONTRACTOR shall provide additional hangers and miscellaneous steel supports as required to distribute the piping system load over several structural members where required or directed. Maximum allowable spacing for piping shall be as follows:

| <u>PVC Piping</u> | <u>Maximum Spacing</u> |
|-------------------|------------------------|
| 3/4" thru 2" | 5'-0" |
| 2 1/2" thru 4" | 6'-0" |
| 6" thru 10" | 9'-0" |
| 12" thru 14" | 12'-0" |

- 4. Round rods supporting the pipe hangers shall be of the following dimensions:

| | |
|-------------------|-----------|
| 1/2" to 2" pipe | -3/8" rod |
| 2-1/2" to 3" pipe | -1/2" rod |
| 4" to 5" pipe | -5/8" rod |
| 6" pipe | -3/4" rod |

5. Hanger rods shall be galvanized steel. Provide for controlling level and slope by turn buckles or other approved means of adjustment and incorporate lock nuts.
6. Where piping is installed side by side, the CONTRACTOR will support the piping by utilizing trapeze type hanger assemblies. Horizontal trapeze member shall be non-metallic channel. The CONTRACTOR shall provide heavier members as required for the load to be supported for the entire span distance. Hanger rods shall be as specified above and properly sized for the load supported, but not less than 5/8 inches diameter.
7. The use of pipe hooks, chains, or perforated iron for pipe hanger supports will not be permitted.
8. Attachment of piping hangers to the building structure shall be provided in a manner approved by the Architect. The CONTRACTOR shall provide concrete inserts to be installed by the General Contractor in the building construction at the time the concrete is poured and hangers shall be attached to these inserts.

K. Piping Installation

1. Trench bottoms shall be smooth and free of rocks and debris. If the trench is dug in ledge rock, hardpan or where large boulders are not removed, place 3 inches of sand or compacted fine-grained soil below pipe. Pipe must be supported over its entire length with firm, stable material. Blocking will not be used to change pipe grade or provide intermittent support over low sections in the trench. Surround the pipe with backfill meeting the requirements of Section 312000 with a particle size of 1-1/2 inch or less and in accordance with the project geotechnical report. Compact in layers not to exceed 6 inches with vibratory method. Follow installation methods of ASTM D2774 "Underground Installation of Thermoplastic Pressure Piping".
2. Installations are to be installed in a straight run of pipe, with a minimum 10 pipe diameters upstream and minimum 5 pipe diameters downstream of any pipe fitting.

L. Flushing, Draining and Cleaning Pipe Systems

1. The CONTRACTOR shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by using compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

M. Expansion and Contraction

1. The CONTRACTOR shall make all necessary provisions for expansion and contraction of piping with offsets, loops, flexible connections and anchors as required to prevent undue strain. The CONTRACTOR shall provide shop drawings for proposed method and arrangement for control of expansion and contraction of piping.

N. Testing

1. All piping installation and pressure testing shall be reviewed by the Owner's testing agency before commencement of backfilling. A minimum notice of one (1) week is required prior to review. Results of review shall be documented.
2. All pool related piping, shall be hydraulically pressure tested (with water, not air) to a pressure of not less than 50 PSI for a period of no less than two (2) hours.
3. Contractor is responsible for the maintenance of a sustained 20 PSI pressure on all pool related piping throughout the course of construction.

4. The Contractor shall adhere to the applicable provisions of Division 22 - Plumbing, "General Provisions" and "Basic Materials and Methods" for installation of piping system.

3.7 EQUIPMENT AND SYSTEMS INSTALLATION

- A. The CONTRACTOR shall assemble and install all equipment, special parts and accessories as shown on pool drawings, specifications and shop drawings of the equipment suppliers.
- B. The CONTRACTOR shall provide all anchors and inserts to be imbedded in the deck including all fittings, inserts and structure sleeves and required anchorage as shown on the plans and as indicated in this section of the specifications. Equipment shall be set true and plumb, using factory jigs where available. Removable equipment items shall be easily removable from anchors and shall fit without noticeable wobble.
- C. Provide templates for all equipment anchors. Provide anchor bolts of the size and spacing as required by the equipment manufacturer. All anchor bolts shall be stainless steel Type 316L and of a length capable of adequate anchorage into rough slab-on-grade allowing for finish deck tile and setting bed. Anchors shall be set and cast into place during building concrete work. Inspect all anchor settings for horizontal and vertical alignment prior to placing concrete.
- D. The CONTRACTOR shall install all equipment and systems in accordance with manufacturer's directions. Equipment shall all be assembled and in place for final observation.
- E. All items necessary to complete this section are shown on the plans or described in the specifications including items that may be purchased by the Owner. Items are detailed and specified as a guide for dimensional purposes. The CONTRACTOR must make provisions accordingly and submit shop drawings and submittals based on that data.

3.8 START-UP AND INSTRUCTION

- A. The CONTRACTOR shall supply the services of an experienced swimming pool operator/instructor for a period of not less than two days (total 16 hours) after the pool(s) have been filled and initially placed in operation. During this period, the Owner's representatives who will be operating the pool(s) shall be thoroughly instructed in all phases of the pool's operation. The CONTRACTOR shall deliver six (6) complete sets of operating and maintenance instructions for the swimming pool, structures, finishes and all component equipment. Prior to leaving the job, the CONTRACTOR shall obtain written certification from the designated Owner's representative acknowledging that the instruction period has been completed and all necessary operating information provided. The CONTRACTOR shall, in his contract, include the cost of two (2) additional days (total 16 hours) of instruction and operational check out by the qualified representative of the CONTRACTOR during the first season of operation.
- B. Written reports of each of these visits outlining the pool's operation, competence and performance of the pool's operation personnel, and other pertinent comments shall be submitted to the Owner and Architect/Engineer within one (1) week after each visit.
- C. The CONTRACTOR shall provide specific written procedures to be followed for emptying and refilling the pool as mentioned previously in this section. The procedures must be included in the bound volume of operating instructions and references in the front index with a note headed by the words: "CAUTION -- VERY IMPORTANT".

END OF SECTION 131100

SECTION 13 11 01 – SWIMMING POOL CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following:
 - 1. Swimming pools:
 - a. Bottom slabs.
 - b. Walls
 - c. Miscellaneous features, slabs on grade and all other elements.
 - 2. Surge tank(s):
 - a. Bottom slab, walls and top slab.
- B. Related Requirements:
 - 1. Division 03 for all concrete not related to swimming pool construction.
 - 2. Division 03 or Division 13 for water tightness testing.
 - 3. Section 13 11 02 "Swimming Pool Shotcrete". Shotcrete may be substituted for swimming pool cast-in-place walls.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.

- c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - e. Special Pool finish Subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, anchor rod and anchorage device installation tolerances if required for equipment installation, under slab pipe encasement requirements, and concrete protection.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Engineer.
- E. Samples: For waterstops.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Waterstops.
 - 6. Curing compounds.
 - 7. Bonding agents.
 - 8. Joint-filler strips, if required.

- 9. Repair materials.
- 10. Dowel bar substitutes.
- C. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
- E. Field quality-control reports.
- F. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.9 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows:
1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301 (ACI 301M).
 2. ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Void Forms (if indicated on drawings): Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

2.4 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
- B. Dowel Bar Substitutes: Tapered, threaded couplers, pre-assembled to reinforcing with mounting plate for attachment to form work and a pressed in metal disc thread protector which can be easily removed. The mechanical connection shall meet building code requirements of developing in tension or compression. The mechanical connection shall be the positive locking, taper threaded type coupler manufactured from high quality steel. The bar ends must be taper threaded using the manufacturer's requirements.
1. Lenton Form Saver; Erico Corp.

2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
1. Portland Cement: ASTM C 150/C 150M, Type I/II, gray.
- C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.

- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- F. Water: ASTM C 94/C 94M and potable.

2.6 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Sika Greenstreak.
 - b. Vynlex Waterstop & Accessories.
 - 2. Profile: Ribbed without center bulb, non-tapered.
 - 3. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick); nontapered.
- B. Non-Expanding Plastic Adhesive Waterstops: Manufactured rectangular or trapezoidal strip, single-component, self-sealing adhesive compound, for adhesive bonding to concrete, 5/8 by 1-1/2 inch.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Synko-Flex SF302, Henry Company.
 - 1) Synko-Flex SF311 Solvent Based Primer.

2.7 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BASF Corporation-Construction Systems; Confilm.
 - b. ChemMasters, Inc; Spray-Film.

- c. Dayton Superior; AquaFilm J74RTU.
 - d. Euclid Chemical Company (The); an RPM company; Eucobar.
 - e. L&M Construction Chemicals, Inc; E-CON.
 - f. Metalcrete Industries; Waterhold.
 - g. Sika Corporation; Caltexol CIMFILM.
 - h. TK Products; TK-2120 TRI-FILM.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of pool finish.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
- a. BASF Corporation-Construction Systems; MasterKure CC 200 WB (Pre-2014: Kure-N-Seal W).
 - b. Dayton Superior; Cure & Seal 1315 J22 WB.
 - c. Euclid Chemical Company (The); an RPM company; Diamond Clear VOX.
 - d. L&M Construction Chemicals, Inc; Dress & Seal WB.
 - e. SpecChem, LLC; Cure & Seal WB 25.
 - f. W.R. Meadows, Inc; Vocomp-20.

2.8 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
1. Provide for cast-in-place concrete coping.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
- a. Dayton Superior Corporation; Conspec Strong Bond.
 - b. Euclid Chemical Company (The), an RPM company; Flex-Con.

- c. W. R. Meadows, Inc.; Sealtight Acry-Lok.
- d. Kaufman Products, Inc.; Surebond.

2.9 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
 - 1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
 - a. Xypex Concentrate.
 - 2. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 3. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 4. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 - 5. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
 - a. Xypex Concentrate.
 - 2. Cement Binder: ASTM C 150/C 150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 3. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 4. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 - 5. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.10 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

- B. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete and concrete with a w/c ratio below 0.50.

2.11 CONCRETE MIXTURES FOR SWIMMING POOL ELEMENTS

- A. Slabs, Walls, Coping and Other Elements: Normal-weight concrete.
 - 1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 - 2. Maximum W/C Ratio: 0.42.
 - 3. Minimum Cement Content: 600 lb/cu. yd.
 - 4. Slump Limit: 4 inches (100 mm), 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 - 5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.

2.12 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

2.14 DRAINAGE FILL

- A. Drainage Course under bottom slabs: Narrowly graded mixture of frost-free, washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
 - 2. Class D, 1 inch (25 mm) for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
 - 1. Comply with pool and gutter profile shown if edges not shown to be chamfered.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. If required for equipment or piping installation, install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 SHORING AND RESHORING INSTALLATION

- A. Comply with ACI 318 (ACI 318M) and ACI 301 (ACI 301M) for design, installation, and removal of shoring and reshoring.
 - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

- E. Dowel bar substitutes may be used in lieu of lap splices.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 3. Locate joints for beams and slabs in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of slabs and beams.
 - 5. Vertical joints in walls shall be located at corners, and in concealed locations where possible.
 - 6. Use a bonding agent:
 - a. At locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - b. At cove joint where cove mortar is placed against hardened wall and slab.
 - c. At coping where coping is placed against hardened wall.
- C. Contraction Joints in Slabs: No contraction joints shall be placed in pool bottom slab.
- D. Joints in Coping:
 - 1. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated, or, 2 feet maximum. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - b. Isolation Joints: Install vertical joint-filler strips at _ feet.
 - 1) Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants are indicated.

3.7 WATERSTOP INSTALLATION

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

- B. Non-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.

- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 FINISHING SLABS AND WALLS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Verify all finish requirements with swimming pool finish subcontractor before finishing concrete.
 - 1. Provide certification, with swimming pool finish subcontractor, that concrete finish complies with manufacturer's recommendations for final pool finish.
- C. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
 - 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- D. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish.
- E. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces exposed to view or to be covered with ceramic tile, paint, or another thin-film-finish coating system.
 - 2. Finish and measure surface, so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch (3.2 mm).

3.11 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

3.12 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 (ACI 301M) for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - 6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean,

square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Headed bolts (if required for equipment and piping installation).
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
8. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Engineer.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 13 11 01

SECTION 13 11 02 – SWIMMING POOL SHOTCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes shotcrete applied by dry-mix or wet-mix process for the following:
 - 1. Swimming pool walls.
- B. Related Sections include the following:
 - 1. Division 13 Section “Swimming Pools” for pool shell tolerances and other items.
 - 2. Division 13 Section “Swimming Pool Cast In Place Concrete” for pool bottom slabs and other pool-related structures.
 - 3. Division 13 Section “Swimming Pool Cast In Place Concrete” for pool coping.
 - 4. Division 03 or Division 13 for water tightness testing.

1.3 DEFINITIONS

- A. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
- B. Dry-Mix Shotcrete: Shotcrete with most of the mixing water added at nozzle.
- C. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
- B. Design Mixtures: For each shotcrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. For predampened dry-mix mixtures, indicate amounts of mixing water to be added to the dry-mix materials before mixing and conveying through the delivery hose.
- C. Shop Drawings: For shotcrete installation. Include support and anchor details; reinforcement materials and grades and details of fabricating, bending, and placing reinforcement; number and location of splices; special reinforcement required for openings through shotcrete

structures; formwork materials and details of formwork fabrication, assembly, and support; and locations of proposed construction joints.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each of the following:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials.
- C. Preconstruction Test Reports: For shotcrete.
- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer employing nozzle operators for the Project, each of whom attains mean core grades not exceeding 2.5, according to ACI 506.2, on preconstruction tests, is ACI Shotcrete Nozzleman certified in Dry-Mix Process for Vertical Position, is ACI Shotcrete Nozzleman certified in Wet-Mix Process for Vertical Position as appropriate to the required shotcrete work.
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. ACI Publications: Comply with ACI 506.2, "Specification for Shotcrete," unless modified by requirements in the Contract Documents.
- D. Shotcrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design shotcrete mixtures.

1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing and inspections indicated below:
 - 1. Produce shotcrete test panels before shotcrete placement according to requirements in ACI 506.2 and ASTM C 1140 for each design mixture, shooting orientation, and nozzle operator. Produce test panels with dimensions of 24 by 24 inches (600 by 600 mm) minimum and of average thickness of shotcrete, but not less than 3-1/2 inches (90 mm).
 - 2. From each test panel, testing agency will obtain six test specimens: one set of three specimens unreinforced and one set of three specimens reinforced. Agency will perform the following:
 - a. Strength Testing: Test each set of unreinforced specimens for compressive strength according to ASTM C 42/C 42M.
 - b. Core Grading: Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practical sizes to minimize number of joints.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufactured according to CRSI's "Manual of Standard Practice" and as follows:
 - 1. For uncoated reinforcement, use all-plastic bar supports.
- C. Reinforcing Anchors: ASTM A 36/A 36M, unheaded rods or ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hex-head bolts; carbon steel; and carbon-steel nuts.
 - 1. Finish: Plain, uncoated.

2.3 SHOTCRETE MATERIALS

- A. Source Limitations for Shotcrete: Obtain each color, size, type, and variety of shotcrete material and shotcrete mixture from single manufacturer with resources to provide shotcrete of consistent quality in appearance and physical properties.
- B. Portland Cement: ASTM C 150, Type I or Type III. Use only one brand and type of cement for Project.
 - 1. Fly Ash: ASTM C 618, Class C or Class F.
- C. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
 - 1. Combined Aggregate Size: ACI 506R or ASTM C 1436, Grading No. 2 sieve analysis.
- D. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
- E. Ground Wire: High-strength steel wire, 0.8 to 1.0 mm in diameter.
- F. Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.4 ADMIXTURES

- A. General: ASTM C 1141, Class A (liquid) or Class B (non-liquid), but limited to the following admixture materials. Provide admixtures for shotcrete that contain not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
 - 1. Accelerating Admixture, Conventional: ASTM C 494/C 494M, Type C or Type E.
 - 2. Pozzolanic Admixture: Fly ash, ground granulated blast-furnace slag, and silica fume as limited in "Shotcrete Materials" Article.

3. Coloring Admixture: Coloring agent as limited in "Shotcrete Materials" Article.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry, or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 SHOTCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of shotcrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 506.2.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based laboratory trial mixture or field test data, or both.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Cementitious Materials: Limit use of fly ash to not exceed, in combination, 15 percent of portland cement by weight.
- D. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
- E. Admixtures: When included in shotcrete design mixtures, use admixtures according to manufacturer's written instructions.
- F. Design-Mixture Adjustments: Subject to compliance with requirements, shotcrete design-mixture adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.7 SHOTCRETE MIXTURES

- A. Shotcrete Mixture: Proportion mixture to provide shotcrete with the following properties:
 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 2. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight wet-mix shotcrete having an air content before pumping of 8 percent with a tolerance of plus or minus 1-1/2 percent.

2.8 SHOTCRETE EQUIPMENT

- A. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
- B. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at

required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.

1. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
 2. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.
- C. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

2.9 BATCHING AND MIXING

- A. Dry-Mix Process: Measure mixture proportions by weight batching according to ASTM C 94/C 94M or by volume batching complying with ASTM C 685/C 685M requirements.
1. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
 2. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.
- B. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and furnish batch ticket information.
1. Comply with ASTM C 685/C 685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

2.10 RELATED MATERIALS

- A. Latex Bonding Agent: ASTM C 1059/C 1059M, Type II.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following;
 - a. Latex Bonding Agent, Type II (Non-Redispersible):
 - 1) Dayton Superior Corporation; Conspec Strong Bond.
 - 2) Euclid Chemical Company (The), an RPM company; Flex-Con.
 - 3) W. R. Meadows, Inc.; Sealtight Acry-Lok.
 - 4) Kaufman Products, Inc.; Surebond

2.11 REPAIR MATERIALS

- A. Concrete Patching Mortar: Chemical treatment for waterproofing concrete.
1. Xypex Concrete Waterproofing by Crystallization, Xypex Chemical Corporation.
 - a. Xypex Concentrate.

2.12 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Available Manufacturers:
 - a. Bometals, Inc.
 - b. Greenstreak.
 - c. Meadows, W. R., Inc.
 - d. Murphy, Paul Plastics Co.
 - e. Progress Unlimited, Inc.
 - f. Tamms Industries, Inc.
 - g. Vinylex Corp.
 - 2. Profile: Ribbed without center bulb.
 - 3. Dimensions: 4 inches by 3/16 inch thick (150 mm by 10 mm thick); nontapered.
- B. Non-Expanding Plastic Adhesive Waterstops: Manufactured rectangular or trapezoidal strip, single-component, self-sealing adhesive compound, for adhesive bonding to concrete, 5/8 by 1-1/2 inch.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Synko-Flex SF302, Henry Company.
 - 1) Synko-Flex SF311 Solvent Based Primer.

2.13 DRAINAGE FILL

- A. Drainage Course under bottom slabs: Narrowly graded mixture of frost-free, washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Concrete: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces to saturated, surface-dry condition before shotcreting.
 - 1. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.

- B. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces to saturated, surface-dry condition before shotcreting.
- C. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding. Dampen surfaces to saturated, surface-dry condition before shotcreting.
- D. Steel: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

3.2 FORMS

- A. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.
 - 1. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
 - 2. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.
- B. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
- C. Securely embed reinforcing anchors into existing substrates, located as required.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports, bolsters, chairs, spacers, and other devices as required to maintain minimum concrete cover.
- E. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.

3.4 WATERSTOPS

- A. Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions. Prevent displacement during shotcrete application.

3.5 JOINTS

- A. General: Construct joints at locations indicated or as approved by Architect.

- B. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints unless otherwise indicated.

3.6 ALIGNMENT CONTROL

- A. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.

3.7 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.8 APPLICATION

- A. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
- B. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
- C. Apply shotcrete according to ACI 506.2.
- D. Apply dry-mix shotcrete materials within 45 minutes after predampening and wet-mix shotcrete materials within 90 minutes after batching.
- E. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
 - 1. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
- F. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray, and prevent buildup against front face during shotcreting.
- G. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
- H. Do not permit shotcrete to sag, slough, or dislodge.
- I. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
- J. Do not disturb shotcrete surfaces before beginning finishing operations.
- K. Remove ground wires or other alignment-control devices after shotcrete placement.
- L. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
- M. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117, increased by a factor of two.

- N. Cold-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 306.1 and as follows. Protect shotcrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. Discontinue shotcreting when ambient temperature is 40 deg F (4.4 deg C) and falling.
 - 2. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F (10 deg C) and not more than 90 deg F (32 deg C).
 - 3. Do not use frozen materials or materials containing ice or snow.
 - 4. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
 - 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
- O. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to recommendations of ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
 - 1. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 100 deg F (38 deg C) for dry mix or 90 deg F (32 deg C) for wet mix.
 - 2. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F (38 deg C) before shotcreting.

3.9 SURFACE FINISHES

- A. General: Finish shotcrete according to descriptions in ACI 506R.
- B. Natural Finishes:
 - 1. Gun Finish: Natural undisturbed finish as sprayed.
 - 2. Rod Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set. Do not push or float with flat part of trowel.
 - 3. Broom Finish: Rough-textured finish obtained by screeding or cutting exposed face of shotcrete to plane with cutting rod, edge of trowel, or straightedge after initial set; followed by uniform brooming.
- C. Flash-Coat Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finely textured finish.
- D. Flash-Coat with Final Finish: After screeding or cutting exposed face of shotcrete to plane after initial set, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Grading No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve, and apply wood-float finish.

3.10 CURING

- A. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.

- B. Begin curing immediately after placing and finishing but not before free water, if any, has disappeared from shotcrete surface.
- C. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Water-saturated absorptive covers or moisture-retaining covers. Lap and seal sides and ends of covers with 12-inch (300-mm) lap over adjacent covers.
 - 2. Curing Compound: Apply uniformly in continuous operation by power spray according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Apply curing compound to natural gun finish or flash-coat shotcrete at rate of 1 gal./100 sq. ft. (1 L/2.5 sq. m).
- D. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.11 FORM REMOVAL

- A. Forms not supporting weight of shotcrete may be removed after curing for 24 consecutive hours at not less than 50 deg F (10 deg C), provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
 - 1. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
- B. Air Content: ASTM C 173/C 173M, volumetric method or ASTM C 231, pressure method; one test for each compressive-strength test for each mixture of air-entrained, wet-mix shotcrete measured before pumping.
- C. Shotcrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.

- D. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mixture and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed, whichever is less. Produce test panels with dimensions of 24 by 24 inches (600 by 600 mm) minimum and of thickness and reinforcing layout of shotcrete work on project. Testing agency will obtain sets of test specimens from each test panel.
 - 1. Compressive Strength Testing: One set of three unreinforced specimens. Test each set of unreinforced specimens for compressive strength according to ASTM C 1140 and construction testing requirements in ACI 506.2.
 - 2. Visual Core Grading: One set of three reinforced specimens. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.
- E. In-Place Shotcrete Testing: : Only if samples obtained in item D indicate unsatisfactory shotcrete, and only if directed by Owner, Architect or Engineer, take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Do not cut steel reinforcement.
- F. Strength of shotcrete will be considered satisfactory according to the following:
 - 1. Specimen Cores: Mean compressive strength of each set of three unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
 - 2. Specimen Cubes: Mean compressive strength of each set of three unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.

3.13 REPAIRS

- A. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.
 - 1. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs.
 - 2. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders.
 - 3. Dampen surfaces and apply new shotcrete.
- B. Repair core holes from in-place testing according to repair provisions in ACI 301, except do not use shotcrete. Match adjacent color and finish.

3.14 CLEANING

- A. Immediately remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 13 11 02

SECTION 13 11 04 - SWIMMING POOL CEMENTITIOUS FINISH

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a conventional proprietary aggregate plaster finish to the pool structure(s). Provide installation of bond coat prior to application of pool finishes. A ceramic tile trim shall be furnished and installed on the pool perimeter tile band, vertical tile band, gutter handhold, parapet, stair nosing, the ramp entry down to 18" water depth, recessed wall steps, depth markings, wall targets, floor lane markings and all other tile installations as shown and detailed on the contract drawings and in strict accordance with these specifications.
- B. Provide water analysis and pre-fill requirements.

1.2 SUBMITTALS

- A. Samples
 - 1. Prepare 12-inch square panel at the site showing color and texture for pool plaster. Finished cementitious finish work shall match the approved sample panel.
- B. Certificates
 - 1. Submit certificates attesting that the materials furnished meet the requirements specified herein.
- C. Test Report
 - 1. Submit results of domestic water analysis and calculation of amounts of chemicals required to balance pool water on initial fill of pool.

1.3 PRODUCT DELIVERY AND STORAGE

- A. Deliver manufactured materials to site in manufacturers' original unbroken packages or containers bearing manufacturers' name and brand labels. Keep cementitious materials dry until ready to be used and stored off the ground, under cover and away from damp surfaces.

1.4 JOB CONDITIONS

- A. Apply plaster in swimming pool only when ambient temperature is above 40 degrees F and below 90 degrees F, and protect applied plaster from rapid drying by sun or wind until curing is completed or pool is filled with water. Confirm and comply with all applicable manufacturers installation requirements.

1.5 QUALITY ASSURANCE

- A. Plaster installers shall have two years experience in similar pool projects which the Owner may require written proof thereof and proper tools to install plaster.

1.6 SURFACE PREPARATION

- A. Surface Preparation

1. Surface shall be structurally sound and free of any foreign substances and debris that could reduce or impair adhesion, free of dirt, oil, grease or other foreign materials. Sound and remove all loose concrete to firm substrate. Surfaces shall be roughened by sand blasting, water jetting, shot blasting, scarifying, or grinding. Pressure-wash the entire surface. Wash with trisodium phosphate (TSP) using a stiff broom. Thoroughly wash/rinse with clean potable water. Surface defects or holes in the substrate shall be patched per manufacturer's recommendations.
2. Apply and cure bond coat per manufacturer's recommendations. After proper curing of bond coat, lightly moisten with clean potable water prior to application of cementitious finish. Ensure bond coat is free of any foreign matter prior to plastering.

PART 2 - PRODUCTS

2.1 DIAMOND BRITE

- A. The CONTRACTOR shall install a slip-resistant proprietary plaster finish in the areas indicated on the drawings. Description: Diamond Brite finish shall be a blend of selected quartz aggregates and fortified white Portland cement. Color and texture shall be selected by the Architect. Confirm all installation requirements with the manufacturer.
- B. Bond Coat
 1. Bond Kote by SGM, Inc., or approved equal. Apply and cure bond coat per manufacturer's recommendations. After proper curing of bond coat, lightly moisten with clean potable water prior to application of cementitious finish. Ensure bond coat is free of any foreign matter prior to plastering.
- C. Mixing
 1. Thoroughly mix Diamond Brite to a homogeneous lump-free consistency using 1-1/2 to 2 gallons of potable water per 80 lb. bag.
- D. Application
 1. Diamond Brite shall be applied to a uniform thickness of 3/8" to 1/2" over the entire surface. The walls shall be scratch-coated followed by a finish coat. Material applied to the floor after the walls have been applied shall be accelerated to assure uniform setting time throughout the pool surface.
- E. Coverage
 1. Each 80 lb. bag shall cover approximately 25 square feet to a thickness of 3/8".
- F. Proprietary plaster finish is to be applied by a licensed applicator as approved by the manufacturer.

2.2 PEBBLE SHEEN

- A. The CONTRACTOR shall install a slip-resistant pebble stone surface in the areas as indicated on the drawings. Description: Pebble Sheen finish shall be a blend of selected colored aggregates and fortified white Portland cement. Color and texture shall be selected by the Architect. Finish to consist of Pebble Sheen as supplied by Pebble Technology, Inc. (480) 948-5058, or approved equal. Confirm all installation requirements with the manufacturer.

B. Surface Preparation

1. Surface shall be structurally sound and free of any foreign substances and debris that could reduce or impair adhesion, free of dirt, oil, grease or other foreign materials. Sound and remove all loose concrete to firm substrate. Surfaces shall be roughened by sand blasting, water jetting, shot blasting, scarifying, or grinding. Pressure-wash the entire surface. Wash with trisodium phosphate (TSP) using a stiff broom. Thoroughly wash/rinse with clean potable water. Surface defects or holes in the substrate shall be patched per manufacturer's recommendations. Lightly moisten walls and floors prior to application of Pebble Sheen.

C. Bond Coat

1. Scratch Kote System by Multicoat Corporation, Bond Kote by SGM, Inc., or approved equal. Apply and cure bond coat per manufacturer's recommendations. After proper curing of bond coat, lightly moisten with clean potable water prior to application of cementitious finish. Ensure bond coat is free of any foreign matter prior to plastering. If over a waterproof membrane, refer to waterproof section of Swimming Pool specification, section 131100, paragraph 2.17.

D. The cement-pebble stone mixture is to be pneumatically applied to the pool surface.

E. After application of Pebble Sheen material the surface is to be hand troweled for exposure of pebble material.

F. Spray down troweled surface with water to remove excess cement and exposure of pebbles.

G. Surface is allowed a minimum of a 24 hour hardening period. Upon hardening the surface is cleansed with an approved solution as provided by the manufacturer for final exposure and luster of pebble surface.

H. Surface is to be buffed so as to ensure all sharp edges are removed and final surface texture is per the manufacturer's recommendations.

I. Natural pebble stone surface is to be applied by a licensed applicator as approved by the manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION OF SURFACES AND BOND COAT

- A. Clean base surfaces of projections, dust, loose particles, grease, bond breakers, and foreign matter; make sufficiently rough to provide a strong mechanical bond. Sandblast, acid etch, or waterblast to achieve appropriate profile. If acid etching, surfaces must be neutralized and powerwashed prior to proceeding. Do not apply cementitious finishes directly to the surfaces of masonry or concrete that is coated with any acidic solution compound or similar agent until compound or agent is completely removed by water blasting. Thoroughly wash entire surface with 2,000 psi high-pressure water immediately prior to application of finishes. Wet cementitious base surfaces with a fine fog water spray to produce a uniformly moist condition and check screeds, pool equipment, and accessories for correct alignment before work is started. Do not apply finish materials to base surfaces containing frost. Install temporary coverings as required to protect adjoining surfaces from staining or damage by plastering operations.
- B. Prepare and clean concrete surfaces by removing oil or grease. Repair all cracks, surface damage as required prior to proceeding. Protect or mask all adjacent surfaces that are not

scheduled to receive cementitious finish. If expansion or construction joints exist in the areas where cementitious finish will be applied cover plastic joints for protection (if plastic joints are used). Additionally, mark joints for saw-cutting if area will be saw-cut.

- C. Apply and cure bond coat per manufacturer's recommendations. After proper curing of bond coat, lightly moisten with clean potable water prior to application of cementitious finish. Ensure bond coat is free of any foreign matter prior to plastering.
- D. Contractor to thoroughly verify the site conditions prior to the application of cementitious finish. Verify concrete is free of ridges and sharp projections. Verify that all concrete surfaces that are to receive a cementitious finish have cured for a minimum of 5 days. Consideration should be given for the application of a primer for all concrete structures that is over 28 days old to improve bonding.

3.2 APPLICATION OF CEMENTITIOUS FINISH

A. General

- 1. Confirm all application requirements with the manufacturer. Apply finish plaster to the properly prepared substrate at the minimum thickness required by the manufacturer, but no less than 3/8 inch thickness at any location. Apply finish plaster by hand or machine. If plastering machine is used, control fluidity of plaster to have a slump not exceeding 2-1/2 inches when tested using a 2" by 4" by 6" high slump cone. Do not add additional water to the mix subsequent to determining water content to meet this slump. Perform slump test according to following procedure:
 - a. Place cone on level, dry non-absorptive base plate.
 - b. While holding cone firmly against base plate, fill cone with plaster taken directly from hose or nozzle of plastering machine, tamping with a metal rod during filling to release all air bubbles.
 - c. Screed off plaster level with top of cone. Remove cone by lifting it straight up with a slow and smooth motion.
 - d. Place cone in a vertical position adjacent to freed plaster sample suing care not to jiggle base plate.
 - e. Lay straightedge across top of cone being careful not to vibrate cone; measure slump in inches from bottom edge of straightedge to the top of slumped plaster sample.
- 2. All mixing of materials and application procedures shall be done in accordance with the manufacturer's recommendations and requirements. The manufacturer's representative shall visit the site to verify field conditions, confirm materials and application requirements and ascertain that all materials and systems are so installed. Documentation shall be provided to this effect.

B. Workmanship

- 1. Unless otherwise required by the manufacturer, apply finish plaster in two coats by "double-back" method with second coat applied as soon as first coat is tamped and initially floated. Apply plaster with sufficient pressure to provide a good bond on bases. Work plaster to screeds at intervals of from 5 feet to 8 feet on straight surfaces. Apply smooth trowel finish without waves, cracks, trowel marks, ridges, pits, crazing, discoloration, projections, or other imperfections. Form plaster carefully around curves and angles, well up to screeds. Take

special care to prevent sagging and consequent drooping of applications. Produce surfaces free of visible junction marks in finish coat where one day's work adjoins another. Finish proprietary plaster as required by the manufacturer.

2. All cementitious finishes shall be applied by a licensed applicator as approved by the manufacturer.

C. Curing

1. Curing cementitious finishes with fine fog water spray applied to finish coat as frequently as required to prevent dry-out of surface, or as directed by the manufacturer of the cementitious finish. Keep plaster damp until pool is filled. Prevent damage or staining of plaster by troweling or curing.

D. Patching, Pointing, and Cleaning Up

1. Upon completion, cut out and patch loose, cracked, damaged, or defective plaster; patches matching existing plaster in texture, color, and finish, flush with adjoining plaster. Perform pointing and patching of surfaces and plasterwork abutting or adjoining any other finish work in a neat and workmanlike manner. If 10 percent or more of the pools plaster finish is found to be defective, the plaster shall be removed and replaced complete from all surfaces. Remove plaster droppings or spattering from all surfaces. Leave plaster surfaces in clean, unblemished condition ready for pool filling. Remove protective coverings from adjoining surfaces. Remove rubbish and debris from the site.

3.3 PRE-FILL SPECIFICATION

- A. Contractor shall employ a qualified water testing agency to analyze the domestic water with which the pool will be filled within 2 weeks of the plaster date, and shall employ a swimming pool experienced water chemistry consultant to determine types and quantities of chemicals required to ensure calcium-balanced water immediately upon the completion of water filling. Refer to section 13 11 00 for water filling requirements.
 1. Have on hand quantities of the chemicals as determine above, plus 25% overage for follow-up treatment. These chemicals, typically including calcium chloride, bicarbonate of soda, and muriatic acid are in addition to standard bromine/chlorine products and alkalizer/pH control products required elsewhere.
- B. The pool(s) shall not be plastered until directed by the Owner's representative and the filtration system and chlorination system are complete and ready for start-up. The Contractor shall supply all chemicals required for treatment of the pool water.
- C. The Contractor shall submit domestic water analysis to the Owner and/or Architect at least 2 weeks prior to filling the pool(s).

END OF SECTION 13 11 04

SECTION 13 11 03 - SWIMMING POOL TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and General Provisions of the contract, including General and Supplementary Conditions apply to work of this section.

1.2 SUMMARY

- A. The cementitious pool finish shall have ceramic tile markings and trim at locations including the pool perimeter tile band, vertical tile band, stair nosing, the ramp entry down to 18" water depth, gutter handhold, recessed wall steps, depth markings, wall targets, floor lane markings and all other tile installations as shown and detailed on the contract drawings and in strict accordance with these specifications.
- B. The CONTRACTOR shall furnish and install the work of this section.

1.3 RELATED SECTIONS

- A. Division 1 – Mock Ups
- B. Division 7 - Joint Sealers
- C. Division 9 - Ceramic Tile
- D. Section 131100 - Swimming Pool
- E. Section 131104 - Swimming Pool Cementitious Finish

1.4 QUALITY ASSURANCE

- A. Reference Standards: Conform to the following standards unless otherwise required herein.
 - 1. American National Standards Institute (ANSI)
 - a. A108.01 – General Requirements: Subsurfaces and Preparations by Other Trades.
 - b. A108.02 – General Requirements: Materials, Environmental, and Workmanship.
 - c. A108.1, Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile installed with Portland Cement Mortar.
 - d. A108.1C – Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry Set or Latex-Portland Cement Mortar.
 - e. A108.5 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
 - f. A108.10 – Installation of Grout in Tile Work.

- g. A137.1 Standard Specifications for Ceramic Tile.
- 2. American Society for Testing and Materials (ASTM)
 - a. C144-99, Aggregate for Masonry Mortar
 - b. C150-00, Portland Cement
 - c. C171-97a, Sheet Materials for Curing Concrete
 - d. C206-97, Finishing Hydrated Lime
 - e. C207-91 (R1997), Hydrated Lime for Masonry Purposes
 - f. F-1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
 - g. F-2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes
- 3. Tile Council of North America (TCNA); 2013 Edition, Handbook for Ceramic Tile Installation.
- 4. International Standards Organization (ISO)
 - a. ISO 13007 – Part 1: 2004 Ceramic Tiles – Grouts and adhesives; specifies the value of performance requirements for all tile adhesives.
 - b. ISO 13007 – Part 2: 2005 Ceramic Tiles – Grouts and adhesives; test method for adhesives.
 - c. ISO 13007 – Part 3: 2005 Ceramic Tiles – Grouts and adhesives; terms, definitions and specifications for grout.
 - d. ISO 13007 – Part 4: 2005 Ceramic Tiles – Test methods for grout.
- 5. American Concrete Institute
 - a. ACI 302 – Guide for Concrete and Floor Slab Construction
- 6. International Concrete Repair Institute (ICRI)
 - a. Concrete Surface Profile (CSP)
- B. Tile installers shall have two years experience in similar pool projects which the Owner may require written proof thereof and proper tools to install tile.

1.5 MANUFACTURERS

- A. Subject to compliance with requirements provide ceramic tile, mortar and grout of the following manufacturers: American Olean Tile Co. (tile), Dal-Tile Co. (tile), Buchtal (tile), KlinkerSire (tile), Mapei Corp. (thin-set, waterproofing, grout and admixtures), and Laticrete International Inc. (thin-set, waterproofing, grout and admixtures) or approved equal.

1.6 SUBMITTALS

- A. Submit shop drawings indicating tile layout, patterns, joint layout, color arrangement, perimeter conditions, junctions with dissimilar materials, thresholds and setting details.
- B. Submit product data indicating material specifications, characteristics, and instructions for using adhesives and grouts.
- C. Samples:
 - 1. Mount tile and apply grout on 24 x 24 inch backerboard to indicate pattern, color variation and grout joint size variations of each pattern. Furnish mounted tile samples as requested by the architect/owner.
- D. Submit manufacturer's installation instruction.
- E. Submit maintenance data.
 - 1. Include recommended cleaning and stain removal methods, cleaning materials.

1.7 PRODUCT DELIVERY AND STORAGE

- A. Deliver tile materials to site in unopened factory containers sealed with grade seals bearing printed name or manufacturer and the words "Standard Grade". Keep the grade seals intact and containers dry until tiles are used. Keep cementitious materials dry until used.

1.8 JOB CONDITIONS

- A. Inspect and verify job conditions. Report all defects in base surfaces for correction before proceeding.
- B. Maintain a temperature range of 40 degrees Fahrenheit to 90 degrees Fahrenheit during installation of tile and grout materials. Tile installation should cure for a minimum 14 days with average an temperature of 70 degrees, while maintaining the minimum 40 degrees and maximum 90 degrees Fahrenheit, prior to filling pool with water.
- C. Vent temporary heaters to outside to avoid carbon dioxide damage to the new tile work.

1.9 COLORS

- A. Colors to be selected by the Architect or Interior Designer. Note that swimming pool regulations may dictate color selections within the pool tank. See 2.01 Tile Materials for price group breakdowns.

1.10 WARRANTIES

- A. The CONTRACTOR warrants to the Owner that materials and equipment furnished under the contract will be of good quality and new unless otherwise required or permitted by the contract documents, that the work will be free from defects not inherent in the quality required or permitted and that the work will conform with the requirements of the contract documents. Work not conforming to these requirements including substitutions not properly approved and authorized, may be considered defective. The CONTRACTOR'S warranty excludes remedy for damage or defect caused by abuse, improper or insufficient maintenance, improper operation, modifications not executed by the CONTRACTOR or improper wear and tear under normal usage. If required by the Owner, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment. All warranties shall be for a period of five years, unless otherwise specified.

- B. All setting materials shall be provided by the same manufacturer. All mixing materials and application procedures shall be done in accordance with manufacturer's recommendations and requirements. Documentation shall be provided to this effect by the contractor with verification from the manufacturer. This documentation shall be included in the operations and maintenance manual under warranties as documentation qualifying the project for a 15 Year Systems Warranty by Laticrete International, Inc., Mapei, Inc. or approved equal.
- C. The CONTRACTOR shall agree to repair or replace any work at no cost to the Owner upon written notification from the Owner within the warranty period. Pro-rated warranties are not acceptable.

PART 2 - PRODUCTS

2.1 TILE MATERIALS

- A. Standard grade conforming to ANSI A137.1. Provide trimmer units as indicated and specified, including special shapes as detailed or required. Tile patterns and colors shall be as indicated and specified, colors of approved shades. Mesh mounted or perforated paper backed tile is not allowed where the mesh of paper remains as a permanent part of the installation. All 2" x 2" tiles shall be face mounted as guaranteed suitable for pool use by the manufacturer.
- B. All tile shall be "frost-proof" and suited for an outdoor pool installation in a freeze/thaw climate.
- C. Unglazed Ceramic Mosaic Tile
 - 1. Slip-resistant porcelain unglazed ceramic mosaic tile, cushion or all-purpose edges, two inch square from price group 2 for floor, walls, and stair treads unless otherwise noted. Minimum dynamic coefficient of friction shall be 0.42 for wet surfaces and 0.65 for ramped surfaces. Where (special shapes) are required they shall be selected from price group 3. Equivalents provided by Knottile, Dal-Tile or American Olean. For wet surfaces: Buchtal Chroma Mosaics with front mount film (seven color options) 2x2 7161HVF or American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3. For ramps: Buchtal Chroma non-slip mosaics with glass fiber net (four color options) 2x2 7161H. Or for wet surfaces or ramps: Buchtal Chroma non-slip 5x5 32020H thirteen color options) or Dal-Tile or American Olean Unglazed color-body mosaics 2"x2" with 7.5% abrasive grain (7 color options). All colors to be selected by the architect.
 - 2. Ceramic tile band below the pool gutter lip, crown detail at stairs and ramp, and recessed steps shall be selected by Architect from Dal-Tile, Keystone Unglazed Mosaic, 2" x 2" price group 4, American Olean Unglazed color-body porcelain mosaics 2"x2" price group 1-3, or powder glazed 2x2 Buchtal Chroma Mosaics provided by Knottile.
 - 3. Ceramic tile deck band that contains the depth marker letters and numerals shall be selected by the Architect from Dal-Tile, Keystone Unglazed Mosaic, 2"x2", price group 4, American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3.
 - 4. The 15-meter resurfacing marker shall be ceramic tile selected by the Architect from Dal-Tile, Keystone Unglazed Mosaic, 2"x2", price group 4, American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3. The color of the resurfacing marker shall be contrasting with the tile deck band.
 - 5. Contrasting ceramic tile nosings at pool stairs, recessed steps shall be selected by the Architect from Dal-Tile, Keystone Unglazed Mosaic, price group 3 and 4, American Olean Unglazed color-body porcelain mosaics 2"x2", price group 1-3, or Safety Edge Tile from Inlays, Inc.; Black CPC00022, Blue CPC00021, Brown CPC00023 and Green CPC00024.

6. 4" wide contrasting ceramic tile stripe and 12" lane markers on the pool floor shall be selected by Architect from Dal-Tile, Keystone Unglazed Mosaic, 2"x2" price group 3, American Olean Unglazed color-body porcelain mosaics 2"x2" price group 3, or from Knoxite, as 4x4 Buchtal Chroma Colors 22010H-717, 5556 Grey Black and 5535 Blue or 2x2 Mosaic 7160HVF 5535 Grey Black. The main race course wall targets and lane markers shall be black. The cross-course wall targets and lane markers shall be midnight blue.
- D. Handhold Tile at pool perimeter shall be provided as C701 available from Dal-Tile. Hand-hold tiles at the pool perimeter shall be Buchtal Chroma Handhold Edge from Knoxite: **(NOTE TO SPECIFIER: Use for white (more expensive) with dark blue safety strip)** System Finland 119x244 mm (5x10 in) 900402-55730 White with Dark Blue Safety Strip, Internal Corners (pair) 112x112 mm 900402-55732 White with Dark Blue Safety Strip, External Corners 240x119mm 55736-900402 White with Dark Blue Safety Strip.
- (NOTE TO SPECIFIER: Use for grey/beige with dark blue safety strip)** 119x244 mm (5x10 in) 52-55730 Grey/Beige with Dark Blue Safety Strip, Internal Corners (pair) 112x112 mm 52-55732 Grey/Beige with Dark Blue Safety Strip, External Corners (pair) 240x119mm 55736-52 Grey/Beige with Dark Blue Safety Strip.
- (NOTE TO SPECIFIER: Use for grey/beige with black safety strip)** 119x244 (5x10in) 55730-340 Grey/Beige with Black Safety Strip, Internal Corners (pair) 112x112 mm 55732-340 Grey/Beige with Black Safety Strip, External Corners 240x119mm 55736-340 Grey/Beige with Black Safety Strip.
- (NOTE TO SPECIFIER: Use for white (more expensive) with black safety strip)** 119x244 (5x10 in) 55730-900044 White with Black Safety Strip, Internal Corners (pair) 112x112 mm 55732-900044 White with Black Safety Strip, External Corners 240x119mm 55736-900044 White with Black Safety Strip.
- E. Provide tile trim units where indicated or necessary for a complete and finished installation. Provide rounded units for external and internal corners and angles. Provide trim units of material and finish identical to the adjoining tile. Provide SCR/L701 units where the C701 hand hold is interrupted to permit draining. Contractor should request via non-standard production. The SCR/L701 units are available through DalTile at 314-997-6970 or 1-800-672-2086.
- F. Message Tile and Depth Markings
1. Deck messages shall be provided in 1 inch x 1 inch unglazed ceramic tile using "special" characters minimum five inch high as described in American Olean "Ceramic Tile for Swimming Pools" booklet 805 or by Inlays, Inc. Provide 4/5 inch high vertical depth markers on the wall just above/below the water line. Provide waterjet cut solid tile piece, set in a field of 2 inch x 2 inch tiles as described in Inlays, Inc. catalog "Mosaic Pool Markers". All message tile shall contrast with the field tile. Refer to Architect for color selections.
 2. Horizontal and vertical depth markings and warning signs shall be 6" x 6" with 4" high numbers and letters. All horizontal depth markers shall be slip resistant. Single tile abbreviations shall be used for 'FT' and 'IN'. Tile markings shall be used for 'FEET' and 'INCHES'.

2.2 SWIMMING POOL TILE SETTING MATERIALS AND INSTALLATION

A. Surface Preparation

1. Surface preparation shall be in accordance with ACI 302. The surface shall be structurally sound and free of any foreign substances and debris that could reduce or impair adhesion. Sound and remove all loose concrete to firm substrate. Surfaces shall be roughened to a CSP

of 3 to 5 (reference ICRI CSP Standards 7 to 9 for acceptable profile height). Thoroughly wash/rinse with clean potable water. Surface defects or holes in the substrate shall be patched per manufacturer's recommendations.

B. Mortar & Leveling Beds

1. **Bonded Thick Bed Method (Floor / Horizontal Surfaces):** Provide a dry pack, thick mortar bed on horizontal surfaces consisting of either Laticrete 3701 Fortified Mortar Bed, or Mapei, 4:1 bag mix with Planicrete AC Additive. Apply over a properly prepared slurry bond coat. Maximum lift thickness not to exceed 2".
2. **Render- Scratch and Float Coats (Wall / Vertical Surfaces):** Provide wall render (scratch and float coats) on vertical competition turning surfaces to a depth of 4 feet below the water surface, consisting of either Laticrete 3701 Fortified Mortar Bed, or Mapei, 4:1 bag mix with Planicrete AC additive for lift thicknesses up to 1/2". Wall render is made to a plastic consistency when used vertically. Fill all holes and bring surface up to line and plane as required. As manufactured by Laticrete International, Mapei, Inc. or approved equal. Note that slurry bond coats are not required under vertical applications of the render and scratch coat. (Refer to Course Length Tolerances for competitive pools.)

C. Tile Thin-Set

1. Use either Laticrete 254 Platinum one-step, polymer fortified, thin-set mortar or Mapei Ultraflex 3 one-step, polymer modified, thin-set mortar, used in accordance with the manufacturer's requirements. As manufactured by Laticrete International, Mapei, Inc., or approved equal.

D. Tile Grout

1. Use either Laticrete PermaColor Grout or Mapei Ultracolor Plus Grout in accordance with the manufacturer's requirements. As manufactured by Laticrete International, Mapei, Inc., or approved equal.

E. Elastomeric Sealant

1. Use Laticrete Latasil sealant for all inside/outside corners, expansion/movement joints, and to seal lighting/plumbing fixture penetrations. Apply sealant over Latasil 9118 primer. All primer and sealant installation shall be in accordance with the manufacturer's requirements. As manufactured by Laticrete International, Inc., or approved equal.

- F. All mixing and application procedures shall be done in accordance with the manufacturer's recommendations and requirements. The manufacturer's representative shall visit the site to verify field conditions, confirm materials and application requirements and ascertain that all materials and systems are so installed. Documentation shall be provided to this effect.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Complete water tightness test prior to tile installation. Concrete tank shall be watertight per ASTM D5957, the Tile Council of North America, and specification 13 11 00.
- B. Clean substrates of dust, dirt, oil, grease and deleterious substances and mechanically roughen concrete and shotcrete for bond. Conform to applicable reference standards and to recommendations of manufacturers of materials used and meeting ICRI, CSP of 3-5.

C. Substrates to Receive Mortar Setting Beds

1. Dampen concrete substrate to receive tile work according to above referenced standards or tile manufacturer's instructions, as required.

D. Substrates to receive thin set tile applications shall meet normal construction tolerances of 1/4" in 10' where competition tolerances do not apply, and shall meet competition tolerances where required elsewhere in these specifications, and shall be free of bumps, dips and surface irregularities that may effect the satisfactory installation of the tile.

E. Tile Wetting

1. Dampen tile according to above reference standards or tile manufacturer's instructions, as required.

F. Screeds

1. Accurately set temporary screeds to control the finish plane of mortar-bed set tile and remove as soon as setting bed is sufficiently hardened. Fill void spaces from screeds with same mortar.

3.2 TILE INSTALLATION

A. Arrange tile according to patterns detailed. Set tile with flush well-fitted joints, finished in true planes, plumb, square, joints of uniform size. Provide approved trimmers as shown or required. Cut tile without marring. Carefully grind and joint tile edges and cuts.

B. Follow Tile Council of North America installation methods P601 and B417 to achieve total tile system thickness for thin or thick-set.

1. Thick Set

- a. Apply specified setting bed mortar, up to 2" in thickness, on cured and dried concrete pool shell. Tamp and screed to required planes. Spread no more mortar than can be covered with tile before initial set. Do not use re-tempered mortar. Trowel 3/32" to 1/8" thick bond coat over plastic setting bed mortar just before setting tile or apply bond coat to back of each tile placed. 95% coverage of the back of the tile or tile sheet is required. Set tile in position and beat firmly into the setting bed mortar. Bring tile faces to a true and correct plane. Complete all beating and leveling before mortar sets and in no case later than one hour after first placing. When ready, wet and remove paper and glue avoiding excess water. At this time adjust any out-of-line or out-of-level tile.

2. Thin Set

- a. Apply specified bond coat on cured and dried concrete pool shell. Trowel 3/32" to 1/8" thick bond coat over concrete pool shell just before setting tile or apply bond coat to back of each tile placed. 95% coverage of the back of the tile or tile sheet is required. Set tile in position and beat firmly into the setting bed mortar. Bring tile faces to a true and correct plane. Complete all beating and leveling before mortar sets and in no case later than one hour after first placing. When ready, wet and remove paper and glue avoiding excess water. At this time adjust any out-of-line or out-of-level tile.

C. Finished tile surface shall be level and in plane, with no sharp or protruding edges. Tiles out or plane more than 1/16" shall be removed and replaced. Sharp edges shall be stoned smooth.

D. Grout Joint Sizes

1. Unless otherwise approved, install tile with uniform 3/32 inch joint width. A maximum 1/8" joint width may be utilized to meet specific installation requirements, if required.

E. Ceramic Tile Joint Grouting

1. Mix grout to a thick creamy consistency and force into joints for entire thick depth, flush with surface. Clean off all excess and fill skips and gaps before grout sets. Color selection by Architect or Interior Designer. Provide dampness for minimum 3-day curing and polish with clean dry cloths (not required when epoxy grouts are used).

F. Expansion Joints

1. Place expansion joint per applicable TCNA Method P601MB, P601TB, or P602 and conforming to Method EJ171. Provide shop drawings showing backer rod and joint dimensions. All expansion, control, construction, cold, and seismic joints in the pool structure should continue through the tile work, including such joints at vertical surfaces. Movement joints shall be placed at all changes in direction and elevation. Refer to the structural engineer for additional required movement joints. Joint size shall be a minimum of 1/8". Joints through tile work directly over structural joints shall not be narrower than the structural joint. The Contractor shall use cement compatible coatings when using chalk lines for joint layout purposes.

G. Fill and Empty Rates

1. Use a fill and drain rate of 2 feet per 24 hours to minimize thermal shock and structural movement. Maintain a temperature differential of 10 degrees Fahrenheit or less between the pool water and the substrate during fill and drain cycles.

3.3 TESTING AND INSPECTION

- A. Before filling of the pool, and its subsequent provisional acceptance at substantial completion, the tile installation shall be visually inspected and sounded in the presence of the Architects and/or the Owner's representative to verify adhesion of the tile to its substrate as well as its overall compliance with the requirements of this Section.
- B. Any and all tile work found to be loose, improperly adhered, out of plane, misaligned or otherwise non-conforming shall be removed and replaced at no additional cost to the Owner.

3.4 CLEANING

- A. Upon completion of placement and grouting, clean tile installation as recommended by TCNA and manufacturers of proprietary materials. Tile shall be cleaned with pH neutral solutions, free of both sodium and potassium, in accordance with the tile and grout manufacturer's printed instruction.
- B. Leave finished installation clean and free of cracked, chipped, broken, un-bonded or otherwise defective tile work.
- C. Protect installed tile work with non-staining Kraft paper, polyethylene sheeting, or other approved heavy covering during the construction period to prevent damage.

3.5 REPLACEMENT TILE

- A. Provide Owner with approximately 10% or 25 square feet (whichever is least) of each color and type tile used on the project for Owner's repair and replacement requirements.

END OF SECTION 13 11 03

SECTION 13 11 06 - SWIMMING POOL TIMING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in the Table of Contents, shall be included in and made a part of this Section.

1.2 SUMMARY OF WORK

- A. Introduction
 - 1. Provide all labor, materials, equipment and services necessary to install a complete electronic timing and scoreboard system with multi-sport capability for race swimming, diving, water polo, and pace clock.
- B. Work included in this section
 - 1. It is the intent of this section to place the entire responsibility for the complete electronic timing and scoreboard system (including all appropriate connections) with multi-sport capability under one vested supplier. The supplier is responsible for providing full integration of this system. Multiple suppliers for a system will not be approved.
- C. Related work specified in Electrical sections. Reference Division 26 – Electrical. Work to be completed by other contractors.
 - 1. Ground and bond all pool structures, fittings and equipment in accordance with Article 680 of the N.E.C. Test and verify that the system electrical ground is true and solid. Provide certification to this effort.
 - 2. Obtain permits, inspections, and approvals of all wiring including grounding and bonding of all metal components associated with the pool in accordance with Local, State and National Electrical Codes.
 - 3. Install power, conduits, electrical boxes, ethernet connections and wiring for the Contractor furnished electronic timing and scoreboard system with multi-sport capability for race swimming, diving, water polo and pace clock.
 - 4. Supply junction boxes for all equipment outlined in these specifications and depicted on the timing system drawings.
- D. Basis of Design:
 - 1. The complete electronic timing and scoreboard system with multi-sport capability is based upon Colorado Timing System, Inc.

1.3 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

- A. Colorado Time Systems, Inc., 1551 East 11th St., Loveland, CO 80537, 970-667-1000. (Basis of Design.)

1.4 SUBMITTALS

- A. Submittals shall include the following:
 - 1. Product data
 - 2. Shop drawings detailing system layout
 - 3. Operations and maintenance manuals for system. Manuals shall include a complete parts list.
 - 4. Warranty for each piece of equipment within this section.

1.5 JOB CONDITIONS

- A. Manufacturers proposing to submit a quotation for the electronic timing and scoreboard system must confirm that all embedded items are compatible with the installation of their respective systems.
- B. Manufacturers shall review the construction documents and shall notify the architect 10 days prior to the bid date of conflicts or additions to the work of other subcontractors for the proper installation of their system.

1.6 WARRANTIES

- A. The CONTRACTOR shall warranty the completed installation of all systems in this section for one year.
- B. The manufacturer shall warranty the scoreboard, computer consoles, touchpads, pace clocks and starting system for two years.
- C. The manufacturer shall warranty the titanium timing system wall plate and deck plates for five years.

PART 2 -PRODUCTS

2.1 SCOREBOARD SYSTEM

- A. LED-R Numeric Scoreboard System (Located over the facility Entry-refer to timing layout plan)
 - 1. LED-R Scoreboard system shall display all necessary information to time swimming, diving, and water polo in compliance with the appropriate sanctioning body – USA SWIMMING, USA DIVING, and NFHS.
 - a. Basis of Design: LED-R Scoreboard System is based upon Colorado Timing System, Inc.
 - 2. Each line of scoreboard shall use 10" high LED digits, choosing red or amber color.
 - 3. Display intensity shall be adjustable to 8 levels of brightness, between 500-6500 nits.
 - 4. Each line of scoreboard shall have an internal data selector switch to permit owner/operator selection of data codes to be installed at each line of scoreboard. Data select codes may be manually changed at the scoreboard or logically changed from the timer console. Scoreboards with fixed function displays are unacceptable.

5. Each line of scoreboard can have up to eight operable digits, eight operable decimals, and one operable colon to provide maximum display flexibility and reduced cost. Scoreboards with fixed decimals and colons are unacceptable.
6. Each line of scoreboard shall have an individual internal power supply and individual control circuit to limit loss of data to one line if a malfunction should occur or to permit its use as an independent line of scoreboard.
7. Each line of scoreboard shall have true multi-sport capability through the use of sliding digits to permit reformatting to desired configurations. Digits shall move freely without the use of hand tools.
8. Each line of scoreboard shall be constructed identically (modular) to permit on-site substitution or replacement of failed unit.
9. The scoreboard shall be capable of being used in a time of day mode when not being used in display modes.
10. Power shall be 115VAC, 2 amp per module maximum.
11. Scoreboard shall be constructed for an outdoor installation. Provide outdoor model that meets the specifications.
12. Facility name panel(s) shall be provided per Architect.
13. Scoreboard shall display team scores per Owner.
14. Scoreboard intensity shall be software selectable through the Gen 7 timer with 7 discrete settings and one automatic setting.
15. Scoreboard shall display the following minimum requirements:

| | |
|------------|---|
| 1-10 Lines | Lane Place and Time (horizontal – side by side) |
| 1 Line | Home and Guest Scores |
| 1 Line | Event and Heat |

B. Secondary Scoreboard for Diving- MS-0111-Otter Diving Scoreboard

1. Indoor/Outdoor LED scoreboard
2. Overall Dimensions 4.8'(H) x 4'(W) x 4.25" (D)
3. 5" LED Digits
4. Built in wireless/or hardwired 232 for communication to JSYS-3
5. Display shows Current Diver, Total, DD, Dive, Round, Award, Lead Diver, Total and up to 7 judges scores.

C. Scoreboard Hanging Requirements

1. Scoreboard manufacturer shall provide drawings with hanging information.
 - a. Material: Scoreboard hangers shall be 304L stainless steel for an outdoor facility.

SWIMMING POOL TIMING SYSTEM

- b. Coordinate scoreboard hanging requirements with structural engineer prior to the submittal process.
- 2. Anchors – (Provided by Colorado Timing Systems – based on one of the wall types below (a or b) wall to be installed on site prior to the scoreboard installation)
 - a. Hollow Block Construction – (Designed by Structural Engineer & provided by Contractor)
 - 1) Sleeve type anchors feature a split expansion sleeve over a threaded stud bolt body and integral expander, nut and washer. Anchors shall be made of zinc plated Carbon Steel, or Type 18-8 Stainless Steel. Anchors should be installed with carbide tipped hammer drill bits made in accordance to ANSI B212.15-1994. Anchors shall be tested to ASTM E488 criteria and shall meets or exceeds U.S. Government G.S.A. specification A-A-55614 Type 2 (Formerly GSA: FF-S-325 Group VIII, Type 2), California State Fire Marshal, Factory Mutual and Underwriters Laboratories.
 - b. Filled Block or Solid Concrete Construction – (Designed by Structural Engineer & provided by Contractor)
 - 1) Provided by Colorado Timing Systems - The anchor shall be a torque-controlled expansion anchor, which provides consistent performance for a wide range of mechanical anchor applications. This anchor series is available in carbon steel with zinc electroplated coating, carbon steel with hot-dip galvanized coating, 304 stainless steel and 316 stainless steel versions. The threaded stud version of the anchor is available in a variety of diameters ranging from 1/4- to 1-in. depending on the steel and coating type. Applicable base materials include normal-weight concrete, structural lightweight concrete, lightweight concrete over metal deck, and grout-filled concrete masonry. Basis of design is AISI Type 316 stainless steel KWIK Bolt 3 (KB3) manufactured by Hilti, Inc.
 - 2) Three anchors shall have an anchor body, nut and washer that conform to AISI Type 316. The expansion wedges conform to AISI Type 316 stainless steel.
 - 3) Anchor bodies smaller than 3/4-inch, excluding all KWIK Bolt 3 Countersunk, are produced from AISI Type 304 or Type 316 stainless steel having the bolt fracture loads shown in table 1. Anchor bodies 3/4-inch and larger, and all stainless-steel KWIK Bolt 3 Countersunk anchor bodies, are produced from AISI Type 304 or Type 316 stainless steel having the mechanical properties shown in table 1. Nuts meet the dimensional requirements of ASTM F594. Washers meet the dimensional requirements of ANSI B18.22.1, Type A, plain. Stainless steel expansion wedges for AISI Type 304 are made from either AISI Type 304 or Type 316. Stainless steel expansion wedges for AISI Type 316 anchors are made from type 316. All stainless-steel nuts and washers for AISI Type 304 or Type 316 anchors are manufactured from AISI Type 304 or 316, respectively.
- 3. Supports – (Provided by Colorado Timing Systems)
 - a. Unistrut (Numeric Board)
 - 1) Material

- a) Unistrut channels are accurately and carefully cold formed to size from low-carbon strip steel. All spot-welded combination members, except P1001T, are welded 3" (76 mm) maximum on center.

2) Finishes

- a) All channels are available in Perma Green III (GR), Pre-galvanized (PG) conforming to ASTM A653 G90, Hot-dipped galvanized (HG) conforming to ASTM A123.

4. Brackets – (Provided by Colorado Timing Systems)

- a) Per ANSI B1.1- Surface roughness per ANSI B46.1- Surface roughness on holes 250 MAX unless otherwise specified. Variations in form from unmachined features are permitted within established – all filets 0.005-0.020 (APPROX. RADIUS) – Screw threads per ANSI B1.1- Pipe threads commercial standards. All edges and corners 0.005-0.020 (approx. radius or chamfer).
- b) All materials and components used in the assembly of this item must be RoHS complaint material: 12GA (.105) HRS. The finish shall be ZINC CLEAR CHROMATE PLATED. Manufacturer shall break all sharp edges and corners.
- c) All support hardware, brackets, fasteners, hangers, etc. used during installation of the scoreboard shall be Zinc Clear Chromated Plated.

2.2 POOL IS DESIGEND FOR AN ON-DECK TIMING SYSTEM – NOT A DECK PLATE TIMING SYSTEM (GEN 7 LEGACY SWIM TIMER) QTY. 1

- A. Timer shall be a standalone unit with physical connections to timing inputs. Timer shall be controlled by user interface device (computer or tablet) via USB or network.
- B. Timer interface (computer or tablet) shall be supplied with all necessary software to time and score swimming in compliance with the appropriate sanctioning body(ies): USA Swimming and National Federation of High Schools.
- C. Timer shall accept inputs for up to 12 lanes for a parallel wiring installation.
- D. Timer shall time to a user-selectable resolution from 1 second to .001 second. It shall take starts and finishes from the near end and/or far end of the pool. It shall accept inputs from the start system, touchpads, up to three manual backup times per lane, and relay judging platforms.
- E. Timer shall run off of a 12 Volt power supply connected to a standard 110/240 VAC outlet and will automatically switch to (and display on screen of connected interface device) internal battery source power, in case of line power failure without affecting the continuity and accuracy of the timing system.
- F. Timer shall interface to single- and multi-line scoreboard and shall post immediate results to scoreboard in "Lane" or "Place" order (user selectable). The timer shall also have the capability to pull race results from memory and post those results to the scoreboard in "Lane" or "Place" order (user selectable).
- G. Timer shall be capable of communicating wirelessly with wireless scoreboards (2.4GHz) using ZigBee wireless communication.

SWIMMING POOL TIMING SYSTEM

- H. Timer to include internal clock calendar with self-sustaining battery to time/date stamp all results.
- I. Timer shall meet acceptable safety standards. Shall be ETL approved, or equivalent.
- J. User interface shall display complete race status. The interface shall be capable of functioning as a miniature scoreboard displaying information simultaneously for all active lanes including lane number, current length in race or final place, split or finish time, relay judging status indicator, and backup time and backup button status.
- K. All race data, including near and far end splits, shall be stored to internal memory for later recall to facilitate meet management connectivity and printing. Printed reports shall include cumulative and subtractive splits as well as relay judging times (when required).
- L. Backup timing provides backup time via push button provided on a per lane basis should swimmer fail to trigger touchpad or touchpad fails to register. Timer to be capable of accepting up to three backup button times per lane.
- M. Meet memory shall be capable of being transferred to external storage (via USB) or cloud data backup services (i.e. DropBox, Google Drive, etc.).
- N. Relay judging automatically compares the touchpad hit of an incoming swimmer with the starting swimmer's time of departure from the optional relay judging platform. Results display both "plus" and "minus" takeoff times and can be printed and stored in race memory.
- O. Timer shall communicate with meet management peripheral software on a two-way "handshake" basis, enabling the meet manager's resident computer to query the timer's memory via the USB port or via the network at any time for any race results.
- P. The system's Automatic Event Sequencer shall be capable of holding both standard and user defined event sequences. The event order will be able to be downloaded from meet management software. The desired order is user selectable. EVENT SEQUENCES with appropriate race distance and race description for high school, college meets, and two "User Defined" meets to permit construction of custom meets. USA Swimming, YMCA, and FINA. When recalled from memory, race distance and descriptions are automatically selected for the operator.
- Q. Timer shall automatically flag timing discrepancies (in the user interface, on the results printouts, and in stored memory) greater than .30 seconds between touchpad and backup times.
- R. Timer shall have touchpad delay feature with ability to program delays from 1 to 99 seconds.
- S. The user interface software shall permit operation of essential functions including Lane Off/On, Finish Arm, Split Arm, and Print Results directly from the main screen to ensure speed and simplicity of operation during critical race times. The interface shall permit the operator to insert a backup time when required (edit) or to disqualify (DQ), automatically posting it to the scoreboard, and provide automatic re-ranking of results. Any corrections generated by the operation (edit or DQ) shall be clearly identified on the results printouts.
- T. The user interface shall permit the operator to correct for an erroneous touch by adding/subtracting a touchpad hit to correct the lengths completed. The interface shall not permit the operator to finish a race in any lane; timers including such a function are unacceptable because they permit the possibility of cheating.

- U. Timer shall include electronic beeper and LED signaling to indicate touchpad, backup button, and relay judging inputs. Timers which do not allow the user to configure (enable/disable) this feature are unacceptable.
- V. Timer connectivity shall include:
 - 1. USB (Type A) port for external storage.
 - 2. USB (Type B) port for meet management connectivity.
 - 3. USB (Type B) port for user interface computer connectivity.
 - 4. Ethernet port for network connectivity.
 - 5. WiFi (ZigBee) for wireless scoreboard connectivity.
 - 6. Three (3) independent scoreboard output ports.
 - 7. Redundant near and far end connections timing inputs (touchpads, backup button, relay judging platforms) for up to 12 lanes.
 - 8. Start system connection directly to timer.
 - 9. External DC power port.
- W. Timer shall be capable of updating internal software/firmware via Internet connection.
- X. Timer software shall have the ability to adjust the intensity of LED scoreboard brightness.
- Y. When recalled from memory, race distance and descriptions are automatically selected for the operator.
- Z. Printouts shall be on a parallel printer connected to the rear panel of the timer. Printout of race results shall be switch selectable in "Lane" or "Place" order, or both. A single keystroke shall print touchpad and backup button times. Printout shall include race number, event/heat number, event description to facilitate meets, and time & date stamp for each race. The system will allow the user to select any of 8 different data to be printed. Printout of relay judging to include both "plus" and "minus" takeoff times for each leg of the relay.

2.3 SWIMMING TIMING SYSTEM CONNECTORS

- A. Wall Plates
 - 1. Wall plates shall be provided as required in the quantities as shown on the drawings. Wall plates shall be the termination point for connections between deck cables, timers, start system, and other wall plates.
 - a. Wall plates shall permit 50-wire connections to be made through one connector. Military connectors shall be used for starting system integration to prevent accidental disconnection.
 - b. Wall plate shall permit connection of start system, timing system and scoreboard(s).

- c. Wall plate shall mount to 12" x 12" x 6" junction box flush with finished wall, a minimum of 18" above finished floor.

2. Junction Boxes (Provided by Electrical Contractor):

- a. Wall plate timing system components shall fit into a 12" x 12" x 6" PVC junction box.
- b. All conduit interconnects between timing system boxes (wall plates) shall be PVC. Refer to drawings for sizing.
- c. Verify routing of conduit with timing system manufacturer prior to install.

2.4 SWIMMING TIMING START SYSTEM - SS

- A. Swimming Timing Start System (1 required) shall be provided to start the automatic swim timing system. The start system shall drive speakers mounted under the starting blocks, the relay judging platform strobe lights and deck side start indicators, with microphone.
 1. Basis of Design: Swimming Timing Start System is based upon the CHAMPIONSHIP START SYSTEM as manufactured by Colorado Timing System, Inc.
- B. System shall drive up to twenty 6-watt (reflex) corrosion resistant speakers located under the individual starting blocks as well as be able to drive individual speed lights on each starting block.
- C. System shall have the capability to use wired microphones and shall have a volume control on each microphone input.
- D. Start system shall have a high impact resistant plastic molded enclosure.
- E. System shall have external connections for additional strobe light, speaker output and start output.
- F. The system shall run off of an external 12-volt power and have 2 internal gel cell batteries. The internal batteries will automatically be recharged while the starter is plugged in to the external power supply.
- G. There shall be a LED warning light on the system showing when the internal batteries are starting to get low on power.
- H. Starting Block Speaker:
 1. Provided one speaker per championship starting block, plus one spare speaker (11 required). Speaker shall be mounted on starting platform. Speaker shall be corrosion resistant and designed to be used in an aquatic environment and rated for such use.
 - a. Basis of Design: The starting block speaker is based upon the CTS MODEL SP-6/45 as supplied by Colorado Timing System, Inc.
 2. The loudspeaker shall be a flex driver type horn projector of integrated construction. It shall be rated 6 watts for voice or music material with an on-axis frequency response of 320-6000 Hz ("6dB). The sound pressure level shall average 97dB(1W/1M) for 500 to 5000 Hz.
 3. The horn and mounting base shall be tan in color and constructed of impact & UV resistant ABS, which will retain mechanical properties from -20q to +160qF. The driver cone diaphragm

SWIMMING POOL TIMING SYSTEM

shall be moisture resistant. All materials shall resist damage from extreme weather exposure. Electrical connector shall be of 2-conductor banana type, .750 center to center.

4. Provision for mounting shall be clearance slots in the adjustable base and hole location points in the horn flange for adapting unit to be recess mounted. Contractor to coordinate with block manufacturer and Colorado Timing Systems.

2.5 DIVING

- A. Diving scoring system shall utilize scoreboard to display diving scores and results without modification from swimming configuration.

- B. Diving Scoring Software:

1. Diving scoring system software shall support standard and synchronized scoring.
2. Accept three (3) judges' input scores and compute award based upon proper formulas for three (3) judges. Software shall be operable with either remote judges' terminals or manual input of flash card scores.
3. System must be expandable to use up to eleven judges scoring terminals.
4. Permit display of the lead diver number, current diver number, dive number, degree of difficulty, judges' scores and diver's calculated award and total score.
5. Permit entry of all diving data into non-volatile memory for storage or receive data from meet management computer without additional modifications. Data shall include diver number, round number, dive number, and position. Degree of difficulty shall be automatically calculated based upon dive number per current USA DIVING/NFHS regulations. Dive degree of difficulty can also be manually input.
6. Automatically recall the diver with round number, dive number and DD using minimal keystrokes. Systems which require live entry of dive information are unacceptable.
7. Permit storage of diver's point totals and provide ranking of the divers at the end of each round.
8. Permit editing of judges' scores if required by meet officials.
9. Provide an output for computer data handling of diving events.
10. Permit two-point deduction from the judges' scores and zero points for a failed dive. Such changes shall be clearly shown on the printout.
11. Printout shall provide preliminary data, diver ranking by rounds, and results of individual dives with judges' scores.
12. Judges' terminals shall be housed in sealed, water-resistant, shockproof housing.
13. The terminals shall provide a signal to inform the judge that the diving console has requested a score. Signal shall cease when an appropriate score is transmitted. They shall also allow each judge to input a score with a minimum of keystrokes, review that score via a built-in LCD display, and correct a score if needed before transmitting to the Judging Software.
14. The Software shall provide a switchable mode for sending data to the scoreboard display.

- a. Mode- Automatic- In this mode the software must send the judges scoring information to the display with no software operator interaction.
 - b. Mode- Hold for Authorization – In this mode the software must receive authorization from a referee terminal or an assistant referee terminal prior to sending the scoring data to the display.
- C. Remote Judging Terminal and interface:
1. Interface hub shall plug into the PC via USB 2.0 or greater
 2. Judges terminals shall include a quick release mating connector for connection to the Diving Cable Breakout Box.
 3. Judges' terminals shall include rugged communications cable to connect to the diving interface box. Cable should be removable for easy cost-effective replacement of the cable.
 4. Judges' terminals shall utilize sealed keyboards with a 128x64 Pixel Backlit LCD display suitable for indoor and sunlight readability.
 5. Judges terminal LCD must be capable of displaying Divers Name.
 6. Judges terminal LCD must be capable of displaying Divers Team or Country Name.
 7. Judges terminal LCD must be capable of displaying scores of other judges once the scores have been accepted.
 8. Judges terminal LCD must be capable of displaying Dive and Dive Degree of Difficulty
 9. Judges terminal LCD must be capable of displaying the terminal number, so they can be easily identified to the judge
 10. Judges terminals shall include a request change button to notify the software that the judge's input is requesting permission to correct the submitted score.
 11. Judges terminals must be able to be assigned as a Referee's terminal or Assistant Referee's terminal allowing the device to control when the judging data is transmitted to the scoreboard display.
 12. Provide three (3) Judging Terminals (JT-01) with associated cables. Provide one interface hub box (IH-01) with associated cables. Provide one (1) cable breakout box (CB-01) with associated cables.

2.6 WATER POLO

- A. Water Polo Table Top Controller
1. Provide water polo table top controller (1 required) for water polo scoring. Controller shall have:
 - a. Buttons with tactile dome feedback
 - b. Large transfective LCD screen that is easily readable in all environments from darkness to bright sunlight

- c. Built-In real time clock to keep time of day
- d. Configurable defaults allow customizing to your league rules
- e. Slide-in keyboard insert
- f. Able to operate multiple scoreboards with one controller
- g. Supports the external Run/Stop/Reset switch to allow for additional clock operators
- h. Include (1 RSR) Stop/Start/Reset switch

B. Portable Deck Clock (Shot Clock)

- 1. Two (2) portable shot clock/pace clock shall be provided for the water polo course.
 - a. Basis of Design: The portable deck clock (shot clock) is based upon the DC-1500 as manufactured by Colorado Timing System, Inc.
- 2. The clock shall include a ruggedized polyethylene enclosure that is water and sun resistant and completely corrosion free. The enclosure shall include a built-in handle to allow for easy carrying from point to point.
- 3. The deck clock shall be capable of being used as a game/shot clock for many sports or set to pace in time of day.
- 4. The deck clock shall include LED digits with variable intensity settings to allow for visibility in a variety of environments and times of day or night. Time of day or game time shall be displayed at the top of the clock, with 5" digits displaying hours and minutes. 10" digits shall show seconds for pacing or shot time.
- 5. The deck clock shall in an integrated 2.4GHz wireless adaptor to receive game/shot data from tabletop or handheld controllers. Data can also be received from a Multi-Sport Computer/Timing System with a wireless adapter.
- 6. The deck clock shall be capable of providing pace in time of day (hours, minutes and seconds) without any controller. Multiple clocks shall automatically synchronize in pace mode.
- 7. The clock shall include an integrated horn. The horn shall produce both game and shot tones.
- 8. WHC – 1 wireless hand-held controller QTY (1) required. To be used with Deck Clocks for Water Polo Practice.

2.7 SWIMMING TIMING COMPONENTS

A. Gutter Hung Touchpads

- 1. Provide 11 touchpads (11 required, 10 plus 1 spare) to time swimming, in compliance with the appropriate sanctioning body.
 - a. Basis of Design: The gutter hung touchpad is based upon the AQUAGRIP GUTTER HUNG TOUCHPAD as manufactured by Colorado Timing System, Inc.

2. Touchpad shall be constructed of an all-plastic exterior with only electrical connector metal exposed. Touchpad shall be the following dimensions:
 - a. Touch pad shall be the TP-78G AQUAGRIP, 78" wide x 22" tall x 0.3" thick.
 3. Touchpad shall have a uniform fine grit and non-abrasive surface that prevents swimmer slippage in any direction.
 4. Touchpad markings shall have contrasting colors with a 2" black border and black end-wall cross pattern for portion covered by touchpads.
 5. Touchpad brackets shall be custom made to fit the pool. Contractor to provide sufficient number of brackets for support of each touchpad.
 - a. Contractor to provide an additional 2 spare touchpad brackets.
 6. Touchpad shall have a two-year warranty without a requirement to purchase a protective touchpad cart.
 7. Touchpad caddy for storing the number of touch pads supplied shall be CAD-TP/P.
 8. Provide on-deck cable harness for 10 lanes to support, (3) three buttons, and touch pad. Colorado Time Systems part numbers CH41-10, CH41-10-3.
- B. Push Buttons
1. Provide two (2) back-up buttons for each touchpad provided.
 2. Back-up buttons to be plunger style button with a 5' cable.
- C. Swimming Timing Systems Caddies – CAD-TP/P-Provide (1)
1. Provide touchpad caddy for storing all touch pads. The correct number of touchpad caddies shall be supplied to store all touchpads. Caddy shall be sized to match timing system touch pad widths. Touchpad caddy shall consist of an aluminum frame with four freewheeling casters. The CONTRACTOR is responsible for assembly. Touchpad caddy shall be CAD-TP as manufactured by Colorado Timing Systems, Inc.

2.8 PACE CLOCKS

- A. Multi-Sport Computer/Timing System Pace Clock Program
1. Accessory software program shall turn multi-sport computer and multi-sport scoreboard into an effective training system and coaching tool.
 - a. Basis of Design: GEN7 PACE CLOCK PROGRAM as manufactured by Colorado Timing System, Inc.
 2. Accessory software program shall turn multi-sport computer and multi-sport scoreboard into an effective training system and coaching tool.
 3. Interface to HYTEK's "Workout Manager" software with direct download to computer timer.
 4. Programmable workouts are saved into memory for up to 80 workouts.

SWIMMING POOL TIMING SYSTEM

5. Workouts display on multi-line scoreboard by lane. E. START/STOP all lanes with one keystroke, or individually.
 6. Include programmable "fudge factor" for coaches' election.
- B. Standard Pace (Wall mount – QTY (4))
1. Pace clocks shall be provided as required in the quantities as shown on the drawings.
 - a. Basis of Design: PC-STANDARD as manufactured by Colorado Timing System, Inc.
 2. Pace clock shall have a minimum of two LED intensity settings, and the capability to adjust the LED intensity using the Multi-Sport Computer/Timing System or via the control panel.
 3. Pace clock shall have the capability of being programmed by a hand-held console for pacing functions. Additionally, it shall be capable of being programmed with the Multi-Sport Computer/Timing System.
 4. Pace clock shall have the capability of being located anywhere on the deck, mounted on a wall, or recessed within the wall.
 5. Pace clock shall include a wireless frequency of 60/50Hz and have autosensing power capabilities for 110/220 VAC.
 6. Pace clock shall have four (4) 10" LED digits. Unit with digits less than 10" will not be accepted due to inadequate viewing distance.
 - a. Overall Size (H x W x D): 13.5" x 36.25" x 4.75"
 - b. Weight: 29 lbs
- C. PACE CLOCK PRO (PC-PRO)
1. Provide (1) portable pace clocks with (4) 10" (Red or Amber) LED digits.
 2. Unit with digits less than 10" will not be accepted due to inadequate viewing distance.
 3. Pace Clock shall have a minimum of 15 LED intensity settings, and the capability to adjust the LED intensity using a System 6 Console or via the control panel.
 4. Pace Clock Pro electronic training device shall be provided, enabling swimmers to perfect their starts, relay exchanges, and turn speeds.
 5. Pace clock shall operate on AC power or two internal rechargeable 12 volt Gel cell batteries. The internal battery will automatically be recharged while the clock is plugged in to the external power supply.
 6. Pace clock shall have a battery life of 6 hours/internal rechargeable battery.
 7. Portable pace clock shall have the capability of being located anywhere on the deck, mounted on a wall, or recessed within the wall.
 8. Pace Clock shall have 5 ports to operate in conjunction with the following CTS equipment: push button(s), relay judging platform, start system, and two touchpads.

9. Pace Clock shall be capable of the following 15 training modes: (Additional equipment may be required for some functions.)
 - a. Lap Counter
 - b. Simple Pace Clock
 - c. Pace Clock with Cumulative Splits
 - d. Pace Clocks with Lap Splits
 - e. Relay Exchanges
 - f. Start Reaction
 - g. Turn Speed
 - h. Breakout Time
 - i. Start Reaction & Breakout Time
 - j. Five Single Lane Timing modes
 - k. Mid-race Timing

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

- A. Verify that all work by others, related to this section, is installed.
- B. Carefully examine all the construction documents that affect the work of this section.
- C. Prior to starting work, notify the Architect and General Contractor of any defects requiring correction.
- D. Protect other materials and installed work against damage while completing work in this section.

3.2 INSTALLATION

- A. Furnish and install all custom cables, connectors, scoreboard mounting brackets, and fasteners.
- B. Provide scaffolding and labor for mounting scoreboard and pulling cables.
- C. Furnish and install equipment in accordance with the manufacturers drawings and instructions.
- D. Provide scoreboard mounting, all timing system cable terminations, system checkout, and local operator training at time of installation. Training shall consist of one 4-hour session.
- E. Furnish as-built drawings precisely locating all items.
- F. Wiring and grounding shall be installed in strict accordance with the latest edition of the National Electric Code – Article 680.

END OF SECTION 13 11 06

SECTION 13 34 19 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes a single-story, single-span, single slope, rigid-frame-type pre-engineered metal building of the nominal length, width, eave height, and roof pitch indicated.
 - 1. Exterior walls are covered with field-assembled wall panels attached to framing members using exposed fasteners. Endwalls are not expandable.
 - 2. Roof system consists of the manufacturer's standard standing-seam insulated roof.
 - 3. Manufacturer's standard building components and accessories may be used, provided components, accessories, and complete structure conform to design indicated and specified requirements.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Concrete floor and foundations and installation of anchor bolts are specified in Division 03 Section "Concrete Work."
 - 2. Sealants and caulking are specified in Division 07 Section "Joint Sealers."
 - 3. Finish hardware and provisions for masterkeying are specified in Division 08 Section "Finish Hardware."

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Engineer, design, fabricate and erect the pre-engineered metal building system to withstand loads from winds, gravity, structural movement including movement thermally induced, and to resist in-service use conditions that the building will experience, including exposure to the weather, without failure.
 - 1. Design each member to withstand stresses resulting from combinations of loads that produce the maximum allowable stresses in that member as prescribed in MBMA's "Design Practices Manual."
- B. Design Loads: Basic design loads, as well as auxiliary and collateral loads, are indicated on the drawings.
 - 1. Basic design loads include live load, wind load, and seismic load, in addition to the dead load.
- C. Structural Framing and Roof and Siding Panels: Design primary and secondary structural members and exterior covering materials for applicable loads and combinations of loads in accordance with the Metal Building Manufacturers Association's (MBMA) "Design Practices Manual."
 - 1. Structural Steel: Comply with the American Institute of Steel Construction's (AISC) "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" for design requirements and allowable stresses.
 - 2. Light Gage Steel: Comply with the American Iron and Steel Institute's (AISI) "Specification for the Design of Cold Formed Steel Structural Members" and "Design of Light Gage Steel Diaphragms" for design requirements and allowable stresses.
 - 3. Welded Connections: Comply with the American Welding Society's (AWS) "Standard Code for Arc and Gas Welding in Building Construction" for welding procedures.

- D. Building Accessories: Provide metal building system accessories that comply with the following criteria:
 - 1. Hollow Metal Doors and Frames: Comply with the Steel Door Institute's SDI-100 for types, styles, and design requirements and with ANSI A115 for hardware preparation.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.
- B. Product data consisting of metal building system manufacturer's product information for building components and accessories.
- C. Shop drawings for metal building structural framing system, roofing and siding panels, and other metal building system components and accessories that are not fully detailed or dimensioned in manufacturer's product data.
 - 1. Structural Framing: Furnish complete erection drawings prepared by or under the supervision of a professional engineer legally authorized to practice in the jurisdiction where the Project is located. Include details showing fabrication and assembly of the metal building system. Show anchor bolts settings and sidewall, endwall, and roof framing. Include transverse cross-sections.
 - 2. Roofing and Siding Panels: Provide layouts of panels on walls and roofs, details of edge conditions, joints, corners, custom profiles, supports, anchorages, trim, flashings, closures, and special details. Include transverse cross-sections.
 - 3. Building Accessory Components: Provide details of metal building accessory components to clearly indicate methods of installation including the following:
 - a. Personnel doors: Provide elevations and details of each type of door and frame, including anchors and reinforcement; show location and installation requirements for finish hardware. Provide schedule of doors and frames using the same reference numbers for details and openings as those indicated on the drawings; include complete hardware schedule.
 - b. Overhead Coiling Service Doors: Provide fully dimensioned details of construction, including 1/4-inch scale elevations of door units and not less than 3/4-inch scale details showing door curtain, guides, counterbalance, and method of operation.
 - c. Sheet Metal Accessories: Provide layouts at 1/4-inch scale. Provide details of ventilators, louvers, gutters, downspouts, and other sheet metal accessories at not less than 1-1/2-inch scale showing profiles, methods of joining, and anchorages.
- D. Wiring diagrams from the manufacturer of motor operated overhead service doors detailing power, signal, and control systems differentiating clearly between field-installed and manufacturer-installed wiring.
- E. Samples for initial selection purposes in form of manufacturer's color charts or chips showing full range of colors, textures, and patterns available for metal roofing and siding panels with factory-applied finishes.
- F. Samples for verification purposes of roofing and siding panels. Provide sample panels 12-inch long by actual panel width, in the profile, style, color, and texture indicated. Include clips, battens, fasteners, closures, and other panel accessories.
- G. Installer certificates signed by metal building manufacturer written certification certifying that the installer complies with requirements included under the "Quality Assurance" Article.
- H. Professional engineer's certificate prepared and signed by a Professional Engineer, legally authorized to practice in the jurisdiction where Project is located, verifying that the structural

framing and covering panels meet indicated loading requirements and codes of authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Engage an experienced Installer to erect the pre-engineered metal building who has specialized in the erection and installation of types of metal buildings systems similar to that required for this project and who is certified in writing by the metal building system manufacturer as qualified for erection of the manufacturer's products.
- B. **Manufacturer's Qualifications:** Provide pre-engineered metal buildings manufactured by a firm experienced in manufacturing metal buildings systems that are similar to those indicated for this project and have a record of successful in-service performance.
- C. **Single-Source Responsibility:** Obtain the metal building system components, including structural framing, wall and roof covering, and accessory components, from one source from a single manufacturer.
- D. **Design Criteria:** The drawings indicate sizes, profiles, and dimensional requirements of the pre-engineered metal building system. Metal building systems having equal performance characteristics with deviations from indicated dimensions and profiles may be considered, provided deviations do not change the design concept or intended performance. The burden of proof for equality is on the proposer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver prefabricated components, sheets, panels, and other manufactured items so they will not be damaged or deformed. Package wall and roof panels for protection against transportation damage.
- B. **Handling:** Exercise care in unloading, storing, and erecting wall and roof covering panels to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering. Store metal wall and roof panels so that water accumulations will drain freely. Do not store panels in contact with other materials that might cause staining, denting or other surface damage.

1.7 WARRANTY

- A. **Roofing and Siding Panel Finish Warranty:** Furnish the roofing and siding panel manufacturer's written warranty, covering failure of the factory-applied exterior finish on metal wall and roof panels within the warranty period. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.
 - 1. Warranty period for factory-applied exterior finishes on wall and roof panels is 20 years after the date of Substantial Completion.
- B. **Weathertightness:**
 - 1. The entire roof system including all roof panels, flashings, curbs, interior gutters, etc. shall be warranted by the manufacturer against leaks for a period of 20 years.
 - 2. The warranty shall be issued to the Owner by the Manufacturer at time of entire Project Substantial Completion.
 - 3. The warranty shall guarantee the entire roof system and associated work against defective materials and workmanship of installation.

4. The roof system shall include roof insulation, flashing, metal work, labor, and material shall be guaranteed against failure of workmanship and materials. Repair of the system by the manufacturer, including materials and labor, shall be done at no cost to the Owner for duration of warranty period.
- C. Roofing Contractor: Jointly with any subcontractors employed by him, shall guarantee the work required and performed under this contract will be free from defects in workmanship and materials, and that the building will be and remain waterproof for a five (5) year warranty period, after the Architect accepts the work as substantially complete. The warranty shall be in approved notarized written form, to obligate the Contractor, and subcontractors, to make good the requirements of the warranty. The warranty will be held jointly with the Bonding Company for the first two (2) years and the manufacturer for the remaining three (3) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering metal building systems that may be incorporated in the Work include but are not limited to the following:
1. A & S Building Systems, Inc.
 2. American Buildings Co.; (281) 380-6161.
 3. American Steel Building Co., Inc.; (800) 511-3670.
 4. Behlen Manufacturing Co.; (402) 564-3111.
 5. Bigbee Steel Buildings, Inc.; (256) 383-7322.
 6. Ceco Building Systems, an NRCI Building Systems Company; (800) 474-CECO.
 7. Dean Steel Buildings, Inc., (844) 739-DEAN.
 8. Garco Building Systems, an NRCI Building Systems Company; (800) 941-2291.
 9. Kirby Building Systems, Inc.; (662) 323-8021.
 10. LMB Steel Structures, Inc.
 11. MBCI, an NCI Building Systems company.
 12. Mesco Metal Buildings Corp.
 13. NCI Group, Inc.; (281) 897-7788.
 14. Nucor Building Systems, a division of Nucor Corporation; (888) 669-8195.
 15. Package Steel Buildings Corp.; (800) 225-7242.
 16. Red Dot Buildings; (800) 657-2234.
 17. Rigid Global Buildings; (281) 443-9065.
 18. Southern Structures, Inc.
 19. Space Master Buildings.
 20. Star Buildings Division, H. H. Robertson Co.
 21. United Structures of America; (281) 442-8247.
 22. Varco-Pruden Buildings.

2.2 MATERIALS

- A. Hot-Rolled Structural Steel Shapes: Comply with ASTM A 36 or A 529.
- B. Steel Tubing or Pipe: Comply with ASTM A 500, Grade B, ASTM A 501, or ASTM A 53.
- C. Steel Members Fabricated from Plate or Bar Stock: Provide 42,000 psi minimum yield strength. Comply with ASTM A 529, ASTM A 570, or ASTM A 572.
- D. Steel Members Fabricated by Cold Forming: Comply with ASTM A 1011, Grade 50.
- E. Cold-Rolled Carbon Steel Sheet: Comply with requirements of ASTM A 366 or ASTM A 568.

- F. Hot-Rolled Carbon Steel Sheet: Comply with requirements of ASTM A 568 or ASTM A 569.
- G. Structural Quality Zinc-Coated (Galvanized) Steel Sheet: Comply with ASTM A 446 with G90 coating complying with ASTM A 525. Grade to suit manufacturer's standards.
- H. Bolts for Structural Framing: Comply with ASTM A 307 or ASTM A 325 as necessary for design loads and connection details.
- I. Translucent Panels: Glass-fiber reinforced polyester translucent plastic glazing panels complying with ASTM D3841, Type CC2, general purpose, Grade 2, weather resistant, crinkle finish both sides, weighing not less than 8 oz. per sq. ft. Match configuration of adjacent metal panels.
 - 1. Color: White.
 - 2. Mastic: Nonstaining saturated vinyl polymer as recommended by panel manufacturer for sealing laps.
- J. Thermal Insulation: Glass fiber blanket insulation, complying with ASTM C 991, of 0.5 lb per cu. ft. density, thickness as indicated, with UL flame spread classification of 25 or less, and 2 inch wide continuous vapor-tight edge tabs.
 - 1. Type: ASTM C665, Type 1
 - 2. R-Values (minimum): R-30 for roof. R-19 for walls.
 - 3. Surface Burning Characteristics:
 - a. Flame Spread: 25 or less.
 - b. Smoke Developed: 50 or less.
 - 4. Size/Thickness: 6 inch (R-19) vinyl faced over purlin, plus 8 inch (R-25) unfaced in insulation cavity; unless indicated otherwise on drawings. Vinyl side towards attic/plenum space.
 - 5. Use Gymguard insulation on the Roof/ceiling where no liner panels are specified.
 - 6. Approved Manufacturers/Products:
 - a. CertainTeed Corp. (AcoustaTherm).
 - b. Guardian Fiberglass, Inc.(Thermal Control Batts).
 - c. Johns-Manville (Thermal-SHIELD Thermal Insulation).
 - d. Knauf (Thermal Batt Insulation).
 - e. Owens-Corning (Thermal Batt Insulation).
- K. Vapor Barrier: Vinyl film.
 - 1. Retainer Strips: 26-gage (0.0179-inch) formed galvanized steel retainer clips colored to match the insulation facing.
 - 2. Shall be either a vinyl film (3.2 mil thickness) or vinyl reinforced polyester (VRP) film (3 mil approximate thickness). Vinyl reinforced polyester facing is recommended when air temperatures of 30 degrees F or below are anticipated during shipment or erection.
 - 3. Shall have an Underwriters' Laboratories flame spread rate of 25 or less and a smoke developed rating of 50 or less.
 - 4. Shall have a water vapor transmission value of 1.00 perms for vinyl film facing and 0.02 perms for VRP facing.
 - 5. Color: Shall be white.
 - 6. Width: Shall be 78 inches so as to provide a 3-inch tab projecting beyond each side of the fiberglass blanket.
- L. Paint and Coating Materials: Comply with performance requirements of the federal specifications indicated. Unless specifically indicated otherwise, compliance with compositional requirements of federal specifications indicated is not required.
 - 1. Shop Primer for Ferrous Metal: Fast-curing, lead-free, universal primer, selected by the manufacturer for resistance to normal atmospheric corrosion, compatibility with finish paint

systems, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure. Comply with FS TT-P-645.

2. Shop Primer for Galvanized Metal Surfaces: Zinc dust-zinc oxide primer selected by the manufacturer for compatibility with substrate. Comply with FS TT-P-641.

2.3 STRUCTURAL FRAMING

- A. Rigid Frames: Fabricate from hot-rolled structural steel shapes. Provide factory-welded, shop-painted, built-up "I-beam"-shape or open-web-type frames consisting of tapered or parallel flange beams and tapered columns. Furnish frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly.
 1. Provide length of span and spacing of frames indicated. Slight variations in length of span and frame spacing may be acceptable if necessary to meet manufacturer's standard.
 2. Provide rigid frames at endwalls where indicated.
- B. Primary Endwall Framing: Provide the following primary endwall framing members fabricated for field-bolted assembly:
 1. Endwall Columns: Manufacturer's standard shop-painted, built-up factory-welded "I"-shape or cold-formed "C" sections, fabricated from 14-gage (0.0747-inch) steel.
 2. Endwall Beams: Manufacturer's standard shop-painted "C"-shape roll-formed sections fabricated from 16-gage (0.0598-inch) steel.
- C. Secondary Framing: Provide the following secondary framing members:
 1. Roof Purlins, Sidewall and Endwall Girts: "C"-or "Z"-shaped sections fabricated from 16 gage (0.0598-inch) shop-painted roll-formed steel. Purlin spacers shall be fabricated from 14-gage (0.0747-inch) cold-formed galvanized steel sections.
 2. Eave Struts: Unequal flange "C"-shaped sections formed to provide adequate backup for both wall and roof panels. Fabricate from 16-gage (0.0598-inch) shop-painted roll-formed steel.
 3. Flange and Sag Bracing: 1-5/8- by 1-5/8 inch angles fabricated from 16-gage (0.0598-inch) shop-painted roll-formed steel.
 4. Base or Sill Angles: Fabricate from 14-gage (0.0747-inch) cold-formed galvanized steel sections.
 5. Secondary endwall structural members, except columns and beams, shall be the manufacturer's standard sections fabricated from 14-gage (0.0747-inch) cold-formed galvanized steel.
- D. Wind Bracing: Provide adjustable wind bracing using 1/2 inch diameter threaded steel rods; comply with ASTM A 36 or ASTM A 572, Grade D. Locate interior end bay bracing only where indicated.
- E. Bolts: Provide shop-painted bolts except when structural framing components are in direct contact with roofing and siding panels. Provide zinc-plated or cadmium-plated bolts when structural framing components are in direct contact with roofing and siding panels.
- F. Shop Painting: Clean surfaces to be primed of loose mill scale, rust, dirt, oil, grease, and other matter precluding paint bond. Follow procedures of SSPC-SP3 for power-tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSPC-SP1 for solvent cleaning.
 1. Prime structural steel primary and secondary framing members with the manufacturer's standard rust-inhibitive primer.

2. Prime galvanized members, after phosphoric acid pretreatment, with manufacturer's standard zinc dust-zinc oxide primer.

2.4 ROOF AND WALL PANEL COMPONENTS

- A. Metal Roof Panels:
 1. Panel Profile: Two (2) inch high by 3/4 inch wide rib by 16 inch wide, striated concealed fastener panel.
 2. Metal Roof System: Vertical leg, concealed fastener, standing seam, utilizing male and female rib configurations, with factory applied hot-melt mastic in female rib, continuously locked together by an electrically powered mechanical seaming device during installation.
 3. Gauge: Minimum 24 gauge (UL 90 rated)
 4. Substrate: Galvalume® steel sheet, Grade "D" minimum yield of 50,000 PSI.
 5. Clips: Two (2) piece floating clip, 18 gauge base, 24 gauge top, with factory applied mastic, with two (2) fasteners to structural. Comply with FM 1-90 requirements.
 6. Texture: Striations.
 7. Finish: Premium fluorocarbon coating produced with Kynar 500® (20 year warranty) in color selected by Architect from manufacturer's available colors.
 8. Touch-up Paint: ZRC Cold Galvanizing Compound manufactured by ZRC Chemical Products, Quincy, MA; Galvax Zinc-rich Cold Galvanizing Coating manufactured by Alvin Products, Inc., Lawrence, MA; or paint complying with military specification MILP-21035A, Type I or II.
 9. Approved Product / Manufacturer **SuperLok®** architectural structural (double-lock) standing seam metal roof system manufactured by MBCI, Houston, TX; (281) 445-8555, or Architect approved equal.
- B. Metal Wall Panels (MWP-1)
 1. Panel Profile: One and one quarter (1 ¼") inch high by 26 inch wide, exposed fastener panel.
 2. Gauge: 24 gauge
 3. Substrate: Galvalume Plus® steel sheet, Grade "D" minimum yield of 50,000 PSI.
 4. Texture: Striations
 5. Finish: Premium fluorocarbon coating produced with Kynar® 500 (20 year warranty) in color selected by Architect from manufacturer's available colors.
- C. Metal Wall/Soffit Panels (MWP-2)
 1. Panel Profile: One (1) inch high by 12 inch wide, flush face concealed fastener panel.
 2. Gauge: 24 gauge
 3. Substrate: Galvalume Plus® steel sheet, Grade "D" minimum yield of 50,000 PSI.
 4. Texture: Striations
 5. Finish: Premium fluorocarbon coating produced with Kynar® 500 (20 year warranty) in color selected by Architect from manufacturer's available colors.
 6. Approved product manufacturer: FW 120-2 Metal Wall Panel Manufacturer by MBCI, Houston, TX or Architect approved equal.

2.5 ROOF ACCESSORIES

- A. Eave Gutters: Roll-formed 24 gauge steel sheet in 10 foot or longest practical length, with gutter straps, fasteners and joint sealant. Snap-on gutter straps shall be provided for ease in erection at a maximum spacing of 5 feet-0 inches. Design of the gutter will permit rapid installation or removal after roof and wall sheets are in place. Gutter shall screen the eave ends of roof sheets from view. No portion of the gutter will protrude under the roof panels. Color shall be as selected by Architect from manufacturer's full line.
- B. Downspouts: Shall be 24 gauge steel sheet in 10 foot or longest practical length, rectangular shaped with 16 gauge boot to 6'-0" above finished grade. Downspouts shall have a 45 degree

elbow at the bottom and shall be supported by attachment to the wall covering at 10 feet maximum spacing. Color shall be same as wall panels.

2.7 ROOF INSULATION SYSTEM

- A. Batt or Roll Thermal Insulation:
 - 1. Type: ASTM C665, Type 1.
 - 2. R-Values (minimum): R-30, total.
 - 3. Surface Burning Characteristics:
 - a. Flame Spread: 25 or less.
 - b. Smoke Developed: 50 or less.
 - 4. Size/Thickness: 6 inch vinyl faced over purlin, plus 8 inch unfaced in insulation cavity; unless indicated otherwise on drawings. Vinyl side towards attic/plenum space.
 - 5. Approved Manufacturers/Products:
 - a. CertainTeed Corp. (AcoustaTherm)
 - b. Guardian Fiberglass, Inc.(Thermal Control Batts)
 - c. Johns-Manville (Thermal-SHIELD Thermal Insulation)
 - d. Knauf (Thermal Batt Insulation)
 - e. Owens-Corning (Thermal Batt Insulation).
- B. Vapor Barrier Facing:
 - 1. Shall be either a vinyl film (3.2 mil thickness) or vinyl reinforced polyester (VRP) film (3 mil approximate thickness). Vinyl reinforced polyester facing is recommended when air temperatures of 30 degrees F or below are anticipated during shipment or erection.
 - 2. Shall have an Underwriters' Laboratories flame spread rate of 25 or less and a smoke developed rating of 50 or less.
 - 3. Shall have a water vapor transmission value of 1.00 perms for vinyl film facing and 0.02 perms for VRP facing.
 - 4. Color: Shall be white.
 - 5. Width: Shall be 78 inches so as to provide a 3-inch tab projecting beyond each side of the fiberglass blanket.
- C. Provide thermal break on top of purlin to separate structural steel and girders from aluminum roof panels.

2.7 SHEET METAL ACCESSORIES

- A. General: Provide coated steel sheet metal accessories with coated steel roofing and siding panels.
- B. General: Provide aluminum sheet metal accessories with aluminum roofing and siding panels.
- C. Gutters: Form in 8-foot-long sections, complete with end pieces, outlet tubes, and other special pieces as required. Size in accordance with SMACNA. Join sections with riveted and soldered or sealed joints. Provide expansion-type slip joint at center of runs. Furnish gutter supports spaced 36 inches on center, constructed of same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish to match roof fascia and rake.
- D. Downspouts: Form in 10-foot-long sections, complete with elbows and offsets. Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 5 feet on center in between. Finish to match wall panels.

- E. Roof Ventilators: Provide low-profile, ridge-type circular gravity roof ventilators, size and spacing indicated. Furnish with matching base, bird screen, hood, flashing, closures, and fittings. Finish to match roof panels.
 - 1. Provide directional revolving-type gravity roof ventilators.
 - 2. Provide stationary revolving-type gravity roof ventilators.
 - 3. Reinforce and brace units, with joints properly formed and edges beaded to be watertight under normal positive pressure conditions. Mount ventilators on square-to-round bases designed to match roof pitch and roll-formed to match corrugation profile of roof panels.
 - 4. Provide bird screens of 1/2-inch by 1/2-inch galvanized steel or aluminum mesh.
 - 5. Provide pull-chain-operated, spring-loaded disc-type damper, with fusible link connection.
- F. Wall Louvers: Provide louvers, size and design indicated, of 18-gage (0.0478-inch) steel. Fold or bead blades at edges, set at an angle that excludes driving rains, and secure to frames by riveting or welding. Finish to match wall panels.
 - 1. Provide vertical mullions for louvers 4 feet and more in width, with one mullion for each 4 feet of width.
 - 2. Provide flanges on interior face of frames where air intake or exhaust louvers are indicated to be connected with mechanically operated dampers or metal ductwork.
 - 3. Provide 1/2-inch by 1/2-inch galvanized steel mesh bird screens in rewirable frames on exterior face of louvers. Secure with clips to ensure ease of removal for cleaning and rewiring. Fabricate screens and frames of same type metal as louvers.

2.8 FABRICATION

- A. General: Design prefabricated components and necessary field connections required for erection to permit easy assembly and disassembly.
 - 1. Fabricate components in such a manner that once assembled, they may be disassembled, repackaged, and reassembled with a minimum amount of labor.
 - 2. Clearly and legibly mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
- B. Structural Framing: Shop-fabricate framing components to indicated size and section with base plates, bearing plates, and other plates required for erection, welded in place. Provide holes for anchoring or connections shop-drilled or punched to template dimensions.
 - 1. Shop Connections: Provide power riveted, bolted, or welded shop connections.
 - 2. Field Connections: Provide bolted field connections.

PART 3 - EXECUTION

3.1 ERECTION

- A. Framing: Erect framing true to line, level, plumb, rigid, and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use a nonshrinking grout to obtain uniform bearing and to maintain a level base line elevation. Moist cure grout for not less than 7 days after placement.
- B. Purlins and Girts: Provide rake or gable purlins with tight-fitting closure channels and fascias. Locate and space wall girts to suit door and window arrangements and heights. Secure purlins and girts to structural framing and hold rigidly to a straight line by sag rods.
- C. Bracing: Provide diagonal rod or angle bracing in roof and sidewalls as indicated.
 - 1. Movement-resisting frames may be used in lieu of sidewall rod bracing, to suit manufacturer's standards.

2. Where diaphragm strength of roof or wall covering is adequate to resist wind forces, rod or angle bracing will not be required.
- D. Framed Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical Work. Securely attach to building structural frame.

3.2 ROOFING AND SIDING

- A. General: Arrange and nest sidelap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line. Protect factory finishes from damage.
 1. Field cutting of exterior panels by torch is not permitted.
 2. Provide weatherseal under ridge cap. Flash and seal roof panels at eave and rake with rubber, neoprene, or other closures to exclude weather.
- B. Standing-Seam Roof Panel System: Fasten roof panels to purlins with concealed clip in accordance with the manufacturer's instructions.
 1. Install clips at each support with self-drilling fasteners.
 2. At end laps of panels, install tape caulk between panels.
 3. Install factory-caulked cleats at standing-seam joints. Machine-seam cleats to the panels to provide a weathertight joint.
- C. Wall Sheets: Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete and elsewhere as necessary for waterproofing. Handle and apply sealant and backup in accordance with the sealant manufacturer's recommendations.
 1. Align bottom of wall panels and fasten panels with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws. Fasten window and door frames with machine screws or bolts. When building height requires two rows of panels at gable ends, align lap of gable panels over wall panels at eave height.
 2. Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
 3. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
- D. Sheet Metal Accessories: Install gutters, downspouts, ventilators, louvers, and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weathertight mounting. Adjust operating mechanism for precise operation.
- E. Hollow Metal Doors and Frames: Install doors and frames straight, plumb, and level. Securely anchor frames to building structure. Set units with 1/8-inch maximum clearance between door and frame at jambs and head and 3/4-inch maximum between door and floor. Adjust hardware for proper operation.
- F. Overhead Coiling Doors: Set doors and operating equipment complete with necessary hardware, jamb and head mold stops, anchors, inserts, hangers, and equipment supports in accordance with manufacturer's instructions. Adjust moving hardware for proper operation.
- G. Thermal Insulation: Install insulation concurrently with installation of roof panels in accordance with manufacturer's directions. Install blankets straight and true in one-piece lengths with both sets of tabs sealed to provide a complete vapor barrier. Locate insulation on underside of roof sheets, extending across the top flange of purlin members and held taut and snug to roofing

panels with retainer clips. Install retainer strips at each longitudinal joint, straight and taut, nesting with roof rib to hold insulation in place.

- H. Cleaning and Touch-Up: Clean component surfaces of matter that could preclude paint bond. Touch up abrasions, marks, skips, or other defects to shop-primed surfaces with same type material as shop primer.
- I. Translucent Panels: Attach plastic panels to structural framing in accordance with the manufacturer's instructions.
 - 1. Provide end laps of not less than 6 inches and side laps of not less than 1-1/2 inch corrugations for translucent roofing panels.
 - 2. Align horizontal laps with adjacent roofing panels.
 - 3. Seal intermediate end laps and side laps of translucent panels with translucent mastic.
 - 4. Clean panels in accordance with manufacturer's instructions.

END OF SECTION 13 34 19

SECTION 133419 METAL BUILDING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes pre-engineered, shop fabricated structural steel building frame.

1.2 REFERENCES

- A. American Institute of Steel Construction:
1. AISC S335 - Specification for Structural Steel Buildings Allowable Stress Design, and Plastic Design.
 2. AISC S342L - Load and Resistance Factor Design Specification for Structural Steel Buildings.
 3. AISC S344L - Metric Load and Resistance Factor Design Specification for Structural Steel Buildings.
- B. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 3. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 4. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 5. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 6. ASTM A490 - Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
 7. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 8. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 9. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
 10. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 11. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 12. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 13. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 14. ASTM C991 - Standard Specification for Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings.
 15. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 16. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 17. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

- C. American Welding Society:
 - 1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 - 2. AWS D1.1 - Structural Welding Code - Steel.
- D. Metal Building Manufacturers Association:
 - 1. MBMA - Low Rise Building Systems Manual.
- E. National Fire Protection Association:
 - 1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- F. SSPC: The Society for Protective Coatings:
 - 1. SSPC - Steel Structures Painting Manual.
 - 2. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
- G. Underwriters Laboratories Inc.:
 - 1. UL - Building Materials Directory.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 SYSTEM DESCRIPTION

- A. Single span rigid frame.

1.4 DESIGN REQUIREMENTS

- A. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.
- B. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

1.5 PERFORMANCE REQUIREMENTS

- A. Conform to applicable codes for submission of design calculations, reviewed shop and erection drawings, required for acquiring permits.
- B. Cooperate with regulatory agency or authority and provide data as requested authority having jurisdiction.

1.6 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate assembly dimensions, locations of structural members, connections, attachments, openings, cambers, loads, and reactions; wall and roof system dimensions, panel layout, general construction details, anchorages and method of anchorage, method or installation; framing anchor bolt settings, sizes, and locations from datum, and foundation loads; indicate welded connections with AWS A2.4 welding symbols; indicate net weld lengths; provide professional seal and signature.
- C. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.

PART 2 PRODUCTS

2.1 FABRICATION - FRAMING

- A. Fabricate members in accordance with AISC Specification for plate, bar, tube, or rolled structural shapes.
- B. Provide framing for door window louver skylight, ventilator openings.

PART 3 EXECUTION

3.1 ERECTION - FRAMING

- A. Erect framing in accordance with AISC Specification.
- B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing.
- C. Set column base plates with non-shrink grout to achieve full plate bearing.
- D. Do not field cut or alter structural members without approval of Architect/Engineer.
- E. After erection, prime welds, abrasions, and surfaces not shop primed.

3.2 ERECTION TOLERANCES

- A. Framing Members: 1/4 inch from level; 1/8 inch from plumb.

END OF SECTION 133419

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide all work for mechanical, plumbing and fire protection systems required in the project to be properly installed, tested and performing their intended function.
- B. All materials and equipment for the potable water system shall meet the latest mandates and requirements for lead free required by law that goes into effect January 2014.
- C. The scope of work described in these Specifications and/or indicated on the Drawings shall include (except where otherwise noted) the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all systems. All work shall be accomplished by workmen skilled in the various trades involved.
- D. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the Engineer shall be notified of the discrepancy.

1.3 QUALITY ASSURANCE

- A. Perform all work in accordance with the latest edition of the applicable codes, specifications, local ordinances, industry standards, utility company regulations, nationally accepted codes.
- B. All materials and distribution, and utilization equipment shall be UL Listed.
- C. All equipment and materials shall be new, unused and of United States Domestic manufacture unless approved otherwise by engineer or owner.
- D. Eliminate any abnormal sources of noise that are considered by the Architect or Engineer not to be an inherent part of the systems as designed without additional cost to the Owner.
- E. An approved contractor for the work under this division shall be:
 - 1. A licensed specialist in this field and have the personnel, experience, training, skill, and organization to provide a practical working system.
 - 2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their Owners satisfactorily for not less than 3 years.

1.4 WORK INCLUDED

- A. SYSTEMS: Plumbing Systems installed and work performed under this Division of the Specifications shall include, but not necessarily be limited to, the following as noted below. The connection point for all systems from the site utilities shall be as 5'-0" from the exterior of the building unless specifically otherwise noted.
 - 1. Domestic cold, hot and hot water recirculation systems
 - 2. Sanitary, drainage, waste and vent systems
 - 3. Natural gas/propane gas system
 - 4. Primary and emergency storm drainage systems
 - 5. Propane/air mixture gas systems
 - 6. Grease waste and waste systems from food service areas
 - 7. Domestic water softening system
 - 8. Compressed air system
 - 9. Fuel Oil system
- B. Contract quality control including workmanship, manufacturer's instructions, mock-ups and demonstrations.
 - 1. MOCK-UPS
 - a. Assemble and erect the specified equipment and products complete, with specified anchorage and support devices, seals and finishes.
 - b. Do not proceed with any work involving a mock-up, until the related mock-up has been approved in writing.
 - c. Acceptable mock-ups in place shall be retained in the completed work.
 - d. Perform tests and submit results as specified.
 - 2. SCHEDULING MOCK-UPS
 - a. Schedule demonstration and observation of mock-ups, in phases, with Architect/Engineer.
 - 1) Rough-in.
 - 2) Finish with all appurtenances in place.
 - 3) Insulation installed.
 - 4) Demonstrations

1.5 COORDINATION WITH OTHER TRADES

- A. Coordinate the work of this division with all other divisions to ensure that all components of the mechanical, plumbing and fire protection system will be installed at the proper time and fit the available space.
- B. Locate and size all openings in work of other trades required for the proper installation of the mechanical, plumbing and fire protection system components.
- C. Make all mechanical, plumbing and fire protection connections to all equipment furnished by this division and as required by any other division.
- D. Electrical wiring, control equipment and motor starters indicated on the electrical drawings, except items otherwise specifically noted, shall be furnished and installed by the electrical trades. Items of electrical control equipment specifically mentioned to be furnished by the mechanical trades, either in these specifications or on the mechanical drawings, shall be furnished, mounted and wired by this trade unless where otherwise specified in Division 26 or noted on the electrical drawings to be by the electrical trades.

All wiring shall be in accordance with all requirements of the electrical Sections of these specifications.

- E. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment. All controllers furnished with mechanical equipment shall have overload protection in all phases. It shall be the responsibility of each subcontractor furnishing motors and devices to advise Electrical Contractor of exact function of systems to assure proper type of starter with correct number auxiliary contacts for proper operation of the system.
- F. The mechanical trades shall coordinate with the electrical to ensure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.
- G. The design of the electrical systems is based on the mechanical equipment specified and scheduled on the drawings. Where changes or substitutions are made that involve additional electrical work (larger-size motors, larger number of motors, additional wiring of equipment, etc.), the mechanical trades shall pay the electrical trades for the cost of the additional work, except for changes by bulletin.
- H. Motor control equipment which is furnished loose under Division 23 shall be delivered to the Electrical Contractor at the site for custody, erection in place, and wiring as specified.
- I. Smoke detection systems will be furnished and installed under Division 26 – electrical. Coordinate locations with Electrical Contractor.

1.6 DRAWINGS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Determine exact locations by review of equipment manufacturer's data, by job site measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. The size of the mechanical, plumbing and fire protection equipment indicated on the Drawings may be based on the dimensions of a particular manufacturer. While other listed manufacturers will be acceptable, it is the responsibility of the Contractor to determine if the equipment that the Contractor proposes to furnish will fit in the space. The drawings are not intended to show exact locations of pipes and ducts, or to indicate all offsets and fittings or supports, but rather to indicate approximate layout.
- B. The mechanical, plumbing and fire protection Drawings are necessarily diagrammatic in character and cannot show every connection in detail in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. When the mechanical, electrical, plumbing and fire protection drawings do not give exact details as to the elevation of pipe, conduit and ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Exposed piping and ductwork is generally intended to be installed true and square to the building construction, and located as high as possible

against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets and their location details. Work shall be concealed in all finished areas.

- D. The locations, arrangement and extent of equipment, devices, and other appurtenances related to the installation of work shown on the Drawings are approximate. The Contractor shall not scale drawings, but shall refer to the architectural drawings for exact dimensions of building components. Should a conflict exist between the architectural and engineering drawings regarding dimensions and scale, the Contractor shall notify the Architect of the discrepancy for resolution.
- E. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

1.7 SUBMITTALS

- A. Provide shop drawings and complete product data as indicated in each specification section.
- B. Coordination Drawings: Using the mechanical ductwork shop drawings as a basis, provide a composite set of AutoCAD drawings in which the major mechanical, plumbing and fire protection equipment, ductwork and piping are superimposed on the architectural reflected ceiling plan and structural framing plan. Include spot elevations of bottom of steel along with finished ceiling height. Prepare at 1/8 inch scale or larger, one drawing per building area. Provide 1/4 inch scale enlargements of locations where special attention to rough-in dimensions as required to ensure all systems will fit within the available space.
- C. Shop Drawings will be reviewed and returned to the Contractor with one of the following categories:
 - 1. **Reviewed:** No further submittal action is required. Submittal to be included in O & M Manual.
 - 2. **Revise and Resubmit:** Contractor to resubmit submittal as indicated in comments section of Engineer's Submittal Cover Letter.
 - 3. **Rejected:** Contractor to resubmit new submittal when alternate or substitution is not approved and be required to furnish product named in Specification and or Drawings.
 - 4. **Furnish as Corrected:** Contractor to submit letter verifying that required corrections noted on Engineer's Submittal Cover Letter have been received and complied with by manufacturer. If equipment on site is not in compliance with corrections noted, contractor shall be responsible for the cost of removing and replacing equipment.
- D. Materials and equipment which are purchased or installed without Submittal review and approval will be removed and replaced with specified equipment at Contractor's expense.
- E. Provide a specification review that consists of a copy of related specification section with notations indicating compliance or deviation with each element of specification.
- F. All approvals required by any code or enforcement authority, insurance underwriter, etc. shall be obtained prior to equipment being submitted to the Engineer.

- G. Review of submittals by the Engineer does not relieve the Contractor from the responsibility for complying with all requirements of the Contract Documents. Furthermore, it shall be the responsibility of the Contractor to coordinate the requirements of all approved equipment with other trades and disciplines such as roof openings, wall openings, electrical characteristics, etc.
- H. All submittals shall be identified by the equipment mark or tag identification numbers shown on the Contract Drawings. Each individual submittal item shall be marked to show which specification section pertains to the item.
- I. Submittals shall clearly indicate selection of model numbers, sizes, dimensions, electrical characteristics, etc. of the proposed equipment. Any proposed deviations from specified equipment shall be clearly indicated on the submittal.

1.8 CLOSEOUT SUBMITTALS

- A. Submit in accordance with Division 1 - General Requirements and each specification section.

1.9 INTERFERENCE DRAWINGS

- A. Where field conditions prohibit the installation of the mechanical, plumbing or fire protection system components within the available space as indicated on drawings, the Contractor shall prepare a sketch to the minimum 1/8 inch scale, clearly depicting the conflict along with an alternate installation arrangement that satisfies the design intent of the documents without incurring additional cost.
- B. Obtain written approval of proposed interference resolution prior to proceeding with alternate installation.

1.10 EXISTING CONDITIONS

- A. The Contractor shall be familiar with the required scope of work to accomplish the work required by these documents. All demolition work implied or required shall be included in the scope of this contract.
- B. Outages of services are required by the new installation will only be permitted at a time approved by the Owner. The contractor shall allow the Owner a 2 week window in order to schedule required outages. The time allowed for outages will not be during normal operating hours unless otherwise approved by the Owner. All costs for outages, including overtime charges, shall be included in the contract amount.
- C. Work Sequence, Timing, Coordination with Owner:
 - 1. During the construction of this project, normal facility activities will continue in existing buildings until new buildings or renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems will have to be maintained in service within the occupied spaces of the existing building.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.12 GENERAL ELECTRICAL REQUIREMENTS

- A. Provide electric motors, control panels, certain control and safety devices and control wiring when specified or required for proper operation of electrical systems associated with mechanical equipment specified in Division 23.
- B. Electrical materials and work provided shall be in accordance with Division 26.
- C. Notify Architect/Engineer in writing 14 days before bids are due if it is necessary to increase horsepower of any motors or change any electrical requirements listed or shown. After this period, costs incurred because of changes shall be assumed by the responsible Contractor.

1.13 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

- A. Mechanical equipment with factory assembled and/or attached electric equipment shall be Underwriters' Laboratories (UL) listed as an assembly when such listing is available from UL, and shall meet the latest edition of the National Electrical Code.
- B. Unless otherwise specified, the electrical supply being furnished is a 480 volt, 3 phase, 3 wire, 60 hertz source. A neutral connection will not be provided, the manufacturer shall include any transformers for equipment requiring other voltages (277volt, 220 volt, 120 volt, 24 volt, etc.).
- C. Electric Motors:
 - 1. For each piece of equipment requiring electric drive, provide a motor having starting and running characteristics consistent with torque and speed requirements of the driven machine.
 - 2. Manufacturers furnishing motors shall verify motor horsepower with the characteristic power curves of driven equipment on shop drawings.
 - 3. Each motor shall be furnished in accordance with Section 23 05 13 - Common Motor Requirements For HVAC Equipment.
 - 4. Contractor shall verify electrical characteristics of each motor with electrical drawings.
 - 5. Motors which are shipped loose from equipment shall be set by supplying subcontractor.
 - 6. Alignment of motors factory coupled to equipment and motors field coupled to equipment shall be rechecked by millwright after all connections (belt drives, gear drives, impellers, piping, etc.) have been completed and again after 48 hours of operation in designed service.
 - 7. Where possible, motors shall be factory mounted.

1.14 AS BUILT DRAWINGS

- A. The Contractor shall maintain a record set of drawings indicating all changes in the work from that shown in the Contract Documents. Prior to final acceptance by the Owner, the Contractor shall assemble the complete set of as-built drawings that accurately reflects all changes to indicate actual final construction. All concealed piping shall be dimensionally located from at least two (2) column lines or major building structure elements. Drawings shall be a minimum of 1/8" scale.

- B. The original set of "as-built" drawings shall be scanned and transmitted to the Architect in both full size bond and PDF format.
- A. As Build Drawings: 2 sets are for the Owner's use and one set is for the Architect/Engineer's records). Delivery of these as-built prints and reproducible is a condition of final acceptance. Provide record drawings on one set each, PDF Format and AutoCad 2015 files on disk (CD Rom).
 - 1. Number of Copies: Submit one set of marked up record prints.
 - 2. Number of Copies: Submit copies of record Drawings:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one of file prints.
 - 2) Submit record digital data files and one sets of plots.
 - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and three sets of prints.
 - 2) Submit record digital data files and three sets of record digital data file plots.
 - 3) Plot each drawing file, whether or not changes and additional information were recorded.
- B. As-Built drawings should indicate the following information as a minimum:
 - 1. Indicate all addendum changes to documents.
 - 2. Remove Engineer's seal, name, address and logo from drawings.
 - 3. Mark documents AS-BUILT DRAWINGS.
 - 4. Clearly indicate: DOCUMENT PRODUCED BY.
 - 5. Indicate all changes to construction during construction. Indicate actual routing of all piping, ductwork, etc. that were deviated from construction drawings.
 - 6. Indicate exact location of all underground plumbing and flow line elevations.
 - 7. Indicate exact location of all underground mechanical piping and elevations.
 - 8. Indicate exact location of all underground electrical raceways and elevations.
 - 9. Correct schedule to reflect (actual) equipment furnished and manufacturer.
 - 10. During the execution of work, maintain a complete set of drawings and specifications upon which all locations of equipment, ductwork, piping, devices, and all deviations and changes from the construction documents in the work shall be recorded.
 - 11. Location and size of all ductwork and mechanical piping above ceiling including exact location of isolation of domestic and mechanical valves.
 - 12. Exact location of all electrical equipment in and outside of the building.
 - 13. Fire Protection System documents revised to indicate exact location of all sprinkler heads and zone valves.
 - 14. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
 - 15. Cloud all changes.

1.15 START-UP-SERVICE

- A. The service of a factory-trained representative shall be provided on the jobsite for a minimum of one (1) day to provide the manufacturer's certification and start-up of all major equipment and systems including booster pumps, water heaters, sewage ejectors, lift stations, fuel oil systems, etc. A formal report is to be issued indicating any revisions required for certification of the assembly by the manufacturer. Instruction and training of the operator's personnel shall be provided following certification of the assembly.

1.16 COORDINATION OF TRADES

- A. The Contractor shall give full cooperation to other trades, and shall furnish all information necessary to permit the work of all trades to be installed satisfactorily and with least possible interference or delay.
- B. Piping and other plumbing equipment shall not be installed without first coordinating the installation of same with other trades. The Contractor, at his own expense, shall relocate all uncoordinated piping and other plumbing equipment installed should they interfere with the proper installation and mounting of electrical, HVAC equipment, ceilings and other architectural or structural finishes.
- C. The Contractor shall coordinate the elevations of all piping and equipment above ceilings and in exposed areas with the work of all other disciplines prior to installation.
- D. In areas where more than one trade is required to use common openings in beams, joists, chases, shafts and sleeves for the passage of conduits, raceways, piping, ductwork and other materials, the Contractor must coordinate the positions of all piping and equipment to be furnished under this section so that all items including the materials and equipment of other trades may be accommodated within the space available.
- E. The Contractor shall confirm that work installed under this section does not interfere with the clearances required for finished columns, pilasters, partitions, walls or other architectural or structural elements as shown on the Contract Documents.
- F. Work that is installed under this Contract which interferes with the architectural design or building structure, shall be removed and relocated as required at no additional cost to the Contract.
- G. All offsets, fittings, valves, devices and accessories which may be required are to be provided under this Contract. The Contractor shall examine the entire set of Contract Documents and carefully investigate the structural and finish conditions affecting all his work and shall arrange such work accordingly for the complete satisfactory operation of all systems, providing such fittings, traps, valves, devices and accessories as may be required to meet such conditions.

1.17 WARRANTY

- A. All equipment furnished and installed under this Contract shall be provided with the manufacturer's standard warranty unless otherwise noted.
- B. The Contractor shall make good all defects in material, equipment, or workmanship disclosed within a period of one (1) year from date of building acceptance by the Owner. The phrase "make good" shall mean to furnish promptly, without charge, all work necessary to remedy the defects to the satisfaction of the Engineer.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All equipment, materials, accessories, etc. used shall be new and of current production unless specified otherwise. Equipment not specified in the Contract Documents shall be suitable for the intended use and shall be subject to approval by the Engineer.
- B. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage, or wear.
- C. All equipment shall bear the inspection label of Underwriters Laboratories Inc.
- D. All equipment and material for similar applications or systems shall be provided from the same manufacturer unless noted otherwise.
- E. Cast iron soil pipe and fittings shall bear the collective trademark of the Cast Iron Soil Pipe Institute.

2.2 ACCESS PANELS

- A. Group valves together above suspended ceilings, walls, furred spaces to minimize the number of access panels, but with all valves freely accessible for maintenance. Locate all valves within 1'-0" of access point.
- B. Furnish access panels of proper size to service concealed valves and cleanouts. Panels shall be of the proper type for material in which they occur and are to be furnished by the Contractor, but installed by the particular trade for the material within which the access panel is installed.
- C. Panels shall have flush doors with No.16 USCG steel door and trim No. 16 USCG steel frame, metal wings for keying into construction, concealed hinges, and screwdriver operated stainless steel cam lock. Panels shall be shop coated with one coat of zinc chromate primer. Valves above removable ceilings shall have tile clips by the Contractor for identification.
- D. Access panels are not allowed in gypsum ceilings in public spaces.

2.3 INSULATION

- A. The following shall be insulated:
 - 1. All domestic cold water piping above grade except at horizontal chase branch piping to individual plumbing fixtures.
 - 2. All hot water and hot water return piping except at horizontal chase branch piping to individual plumbing fixtures.
 - 3. All horizontal storm drain piping and roof drain bodies.
 - 4. All hot and cold water piping exposed to areas subject to freezing, refer to "Heat Cable for Freeze Protection of Piping" under Part 2 of Section 22 30 00 for additional requirements.

- B. Domestic hot, cold, hot water recirculation, primary storm drainage, and waste drainage piping shall be insulated with 4 lb. density sectional fiberglass insulation with a thermal conductivity not to exceed 0.24 with white all service jacket and vapor barrier. All joints and seams shall be sealed vapor tight. All seams and staples shall then be covered with "All Service Jacket" three-inch wide tape. Insulation shall be used for exposed piping.
- C. All interior horizontal storm drainage piping systems and roof drain bodies are to be insulated with blanket type glass fiber bonded with thermosetting resin with white vinyl vapor retarding facing, 2" wide stapling/taping tab. Insulation shall be used in concealed spaces.
- D. Materials as specified in this section shall be manufactured by CertainTeed, Johns Manville, Knauf, Owens Corning or equal. Insulation thicknesses shall be as shown in the following table below as minimum requirements. Where different thickness required by code or local jurisdiction, higher standard to be used:

| Minimum Pipe Insulation | | | Insulation Thickness for Pipe Sizes | | | | |
|---|-------------------------|---------|-------------------------------------|----------------|----------------|-------------|------------------|
| Piping System Types | Fluid Temperature Range | | 1 in. and Less | 1-1/4 to 2 in. | 2-1/2 to 4 in. | 5 and 6 in. | 8 in. and Larger |
| | °C | F | In. | In. | In. | In. | In. |
| PLUMBING | | | | | | | |
| Domestic Water | Ambient | Ambient | 0.5 | 1.0 | 1.0 | 1.0 | -- |
| Domestic Hot Water And Hot Water Recirculation | 43-71 | 110-160 | 1.0 | 1.5 | 1.5 | 1.5 | -- |
| Above Grade Drains and Piping Receiving Condensate or Ice Machine Discharge | 4.5-15.5 | 40-60 | 0.5 | 1.0 | 1.0 | 1.5 | -- |
| Horizontal Storm Drainage | Ambient | Ambient | -- | -- | 1.0 | 1.0 | 1.0 |

- E. Insulate all horizontal storm drain piping with fiberglass insulation and with service jacket. For exposed locations provide 1" thick rigid insulation with rigid jacket. Insulate from roof drain body, past first elbow all the way to change to vertical direction, including y-fittings.
- F. Insulate all above slab horizontal sanitary waste piping carrying air-conditioning condensate with minimum 1"-1.5" fiberglass insulation with jacket from floor drain, including traps, all the way to change in direction to vertical.
- G. In natatorium, including equipment rooms, all exposed plumbing piping shall be insulated and protected by a complete aluminum jacketing system. Provide color coded, printed pipe label 10' on center identifying pipe service type (gas, domestic water, storm water, etc.).
- H. Aluminum Jacket:
1. Jacket for piping shall be 0.016 inch thick type 3105 aluminum with factory applied one mil polykraft moisture barrier
 2. Fitting covers shall be factory made 0.024 inch type 1100 aluminum to match pipe covering.
 3. Aluminum jacketing shall be provided for all exposed piping.
 4. Manufacturers:
 - a. Childers
 - b. Pabco

c. RPR

2.4 HEAT CABLE FOR FREEZE PROTECTION OF PIPING

- A. Provide electric heat tracing on all domestic water piping and sanitary traps exposed to areas subject to freezing.
- B. Provide a complete UL Listed, CSA Certified, or FM Approved system of heating cables, components, and controls to prevent pipes from freezing.
- C. Electric heat cable shall be installed linearly along the bottom of the pipe and allowance shall be made for all fittings, valves, pipe supports, etc. Cable shall be installed prior to insulation of the piping system.
- D. Electric cable shall be capable of maintaining a minimum water temperature of 40 degrees F at an ambient air temperature of 0 degrees F.
- E. The electric cable shall be the self-regulating type that responds to varying localized temperature conditions by varying the heat output along its length. This shall be accomplished by a self-regulating core, which varies its resistance continuously with changes in temperature. A constant wattage heater is unacceptable.
- F. Provide a thermostat control, which de-energizes the heating cable when the ambient air temperature is above 40 degrees F (adjustable). The heat cable shall be entirely self-regulating while energized.
- G. Provide all power connection hardware, splices, end seals, etc., to accomplish installation. All hardware shall be by the same manufacturer as the cable.
- H. Electric heating cable and accessories shall be UL Listed. Electric heating cable shall conform to all requirements of Division 26 - Electrical Requirements.
- I. Electric heating cable shall be Raychem XL-Trace or approved equal, 5 watts per foot.
- J. All piping shall be insulated with 1" thick fiberglass insulation.
- K. Heating-cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-2002.
- L. All heating cable components shall be UL Listed, CSA Certified, or FM Approved for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable.

2.5 FLASHING

- A. Vent pipes passing through roof shall be flashed watertight.
- B. The roof connections shall meet the approval of the manufacturer of the roofing materials and shall comply with the roof bond requirements.
- C. All vent piping shall be offset above ceilings or in attic space and as shown on the Drawings to penetrate roofs on the least visible sides of building.

2.6 FLOOR, WALL & CEILING PLATES

- A. Furnish and install heavy gauge chromium plated steel wall and ceiling plates on all exposed pipes in finished areas where they pass through walls, ceilings, etc. Plates shall be of type that will remain permanently in position and where pipes are insulated they shall be of size necessary to cover insulated pipe.

2.7 TRACER WIRE

- A. General:
1. All trace wire and trace wire products shall be domestically manufactured in the U.S.A.
 2. All trace wire shall have HDPE insulation intended for direct bury, color coated per APWA standard for the specific utility being marked.
- B. Trace wire: (Copper clad Steel (CCS) trace wire)
1. Open-Trench Installation: direct burial #12 AWG Solid (0.0808" diameter), steel core soft drawn tracer wire, 250# average tensile break load, 30 mil high molecular-high density polyethylene jacket complying with ASTM-D-1248, 30volt rating. Color shall be "blue" for domestic water (potable) pipelines and "purple" for raw water (non-potable) pipelines. Manufactured by Copperhead Industries part number 1230-SF, or approved equal.
 2. Directional Bore or Jacked Installation: direct burial #12 AWG Solid (0.0808" diameter), steel core hard drawn extra high strength horizontal directional drill tracer wire, 1150# average tensile break load, 45 mil high molecular-high density polyethylene jacket complying with ASTM-D-1248, 30 volt rating. Color shall be "blue" for domestic water (potable) pipelines and "purple" for raw water (non-potable) pipelines. Manufactured by Copperhead Industries part number 1245-HS, or approved equal.
- C. Connectors: (Copper clad Steel (CCS) trace wire)
1. Splices along the continuous run of trace wire for repair of a wire break or replacement of failed segment of wire shall use 3M Brand DBR Direct Bury Splice Kit or approved equal. Approved alternatives must securely connect two or more wires, effectively moisture seal by means of a dielectric non-hardening silicone sealant, manufacturer approved for direct burial and rated for a minimum of 50V.
 2. Branch connections for laterals, turnouts, services and appurtenances shall use DryConn Direct Bury Lug Aqua, or approved equal. Approved alternatives must securely connect one or two wires to the main trace wire without cutting the main trace wire, effectively moisture seal by means of a dielectric non-hardening silicone sealant, manufacturer approved for direct burial and rated for a minimum of 50V.
 3. Non-locking, friction fit, twist-on or taped connectors are not acceptable. Twisting of copper wiring is not acceptable.
- D. Termination/Access: (Copper clad Steel (CCS) trace wire)
1. Terminal box, or "fink box", shall be flush mount type for installation at grade level. Terminal box shall be specifically manufactured for such application.
 2. Terminal Box shall consist of tubular housing, terminal board and removable round lid.
 3. Minimum dimensions shall be 5-1/2" diameter and 8" high. Base shall be sized to fit 4" schedule 40 PVC pipe.

4. Housing and terminal board material shall be high strength ABS or polycarbonate plastic. All materials of construction shall be impervious to chemicals typically used for snow and ice removal and pavement and hardscape maintenance.
 5. Housing and lid shall be designed for service
 - a. Turf and landscape areas
 - 1) Light duty housing with plastic lid
 - b. Hardscape areas
 - 1) Heavy duty housing with cast iron or ductile iron lid
 - c. Roadway, driveway and parking lot applications not allowed
 6. Terminal board shall have nickel plated brass terminals. Number of terminals shall be as required for specific installation with four spare terminals, minimum.
- E. Grounding: (Copper clad Steel (CCS) trace wire)
1. Grounding of trace wire shall be achieved by use of a drive-in magnesium grounding anode rod with a minimum of 20ft of #14 red HDPE insulated copper clad steel wire connected to anode (minimum 0.5 lb.) specifically manufactured for this purpose, and buried at the same elevation as the utility.
 2. Drive in Magnesium Anode: Copperhead Part # ANO-1005 (1.5 lb).

2.8 GALVANIC PROTECTION

- A. Insulate joints between dissimilar metals with suitable isolation gasket and bolts with fiber ferrules and washers and/or suitable armored insulation fittings by Clearflow, Crane, Capital, or Epco, so there will be no contact between the metals or with insulating bushings.

2.9 PIPING SYSTEMS IDENTIFICATION

- A. A marker showing the service and an arrow indicating the direction of flow shall be applied on all of the following piping systems applicable to the project installed under this section of the Specifications:
1. Domestic hot, cold and hot water recirculation water piping
 2. Gas piping
 3. Primary and emergency storm drainage piping
 4. Sanitary, waste and vent piping
 5. Softened water piping
 6. Condensate Drain Piping
- B. Piping identification shall be applied on all piping systems in areas of exposed construction and in areas with accessible or lay-in ceilings. The piping shall be labeled at each wall and floor penetration (both sides), and at connections to equipment. In addition, straight runs of piping shall be labeled at intervals not greater than 25 feet.
- C. The letter size and background color shall conform to the Identification of Pipe System ANSI A-13-1. The vinyl plastic markers shall be as manufactured by Seton Name-Plate Company, W. H. Brady Company, or Westline products.
- D. Each valve in the Plumbing and Fire Protection systems is to be provided with an individually numbered valve tag (stamped numbered tags). Provide Identification Tags on all Emergency fixture and unit or Shut off valves.
- E. Valve tags are to be brass or plastic laminate, 1-1/2" minimum diameter with brass chain and hook for securing to the valve.

- F. Valve tags will include a "P" or "FP" lettering designation to indicate the appropriate system. Numbering shall be consecutive for each service of either the Plumbing or Fire Protection systems.
- G. A printed list or schematic drawing shall be compiled for each system indicating the location and detailed description of the system or equipment served.
- H. One copy of each list shall be framed and mounted at the location designated by the Building Engineer. An additional copy of each list is to be included in the Operations and Maintenance Manual.

2.10 EQUIPMENT LABELING

- A. All equipment shall be labeled. This shall include all pumps, water heaters, storage tanks, and other similar equipment.
- B. Equipment labeling shall be one of the following, unless noted or specified otherwise.
 - 1. Permanently attached plastic laminate signs with 1" high lettering.
 - 2. Stencil painted identification, 2" high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

PART 3 - EXECUTION

3.1 OWNER INSTRUCTION - GENERAL

- A. Provide on-site Owner training for all new equipment by factory trained specialists.
- B. Use Operation and Maintenance manuals and actual equipment installed as basis for instruction.
- C. At conclusion of on-site training program have Owner personnel sign written certification they have completed training and understand equipment operation. Include copy of training certificates in final Operation and Maintenance manual submission.
- D. No retainage shall be released until Owner has received all Operations and Maintenance manuals and as-built drawings and first O&M walk
- E. Refer to individual equipment specifications for additional training requirements.
- F. All equipment and materials shall be completely installed, adjusted, and fully operational with all accessories and connections.
- G. Equipment, piping, ductwork, etc. shall fit into the spaces provided in the building and shall be installed at such times and in such a manner as to avoid damage and as required by the job progress. The Contractor shall coordinate work with other trades and locate work described herein to avoid interferences with structural, electrical and architectural work. Equipment, accessories and similar items requiring normal servicing or maintenance shall be accessible.
- H. The Engineer reserves the right to direct the removal of any item which, in his opinion, does not present an orderly and reasonably neat or workmanlike appearance. Such removal and replacement shall be done when directed by the Engineer and without additional cost to the Owner.

- I. Mounting heights, unless otherwise noted, are to the finished bottom of the device.

3.2 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to final inspection, conduct an on-site training program to instruct the Owner's operating personnel in the operation and maintenance of the mechanical systems.
 - 1. Provide the training during the Owner's regular working day.
 - 2. The Instructors shall each be experienced in their phase of operation and maintenance of building mechanical systems and with the project.
- B. Time to be allocated for instructions.
 - 1. Minimum of 8 hours dedicated instructor time.
 - 2. 4 hours on each of 2 days.
- C. Before proceeding with the on-site training program, submit the program syllabus; proposed time and dates; and other pertinent information for review and approval.
 - 1. One copy to the Owner.
 - 2. One copy to the Architect/Engineer.
- D. The Owner will provide a list of personnel to receive instructions, and will coordinate their attendance at the agreed upon times.
- E. Use the operation and maintenance manuals as the basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.
- G. Demonstrate equipment functions (both individually and as part of the total integrated system).
- H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.
- I. Submit a report within one week after completion of the training program that instructions have been satisfactorily completed. Give time and date of each demonstration and hours devoted to the demonstration, with a list of people present.
- J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he/she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.
- K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operation and Maintenance Manual":

3.3 GENERAL REQUIREMENTS

- A. All equipment and materials shall be completely installed, adjusted, and fully operational with all accessories and connections.
- B. Equipment, piping, ductwork, etc. shall fit into the spaces provided in the building and shall be installed at such times and in such a manner as to avoid damage and as required by the job progress. The Contractor shall coordinate work with other trades and

locate work described herein to avoid interferences with structural, electrical and architectural work. Equipment, accessories and similar items requiring normal servicing or maintenance shall be accessible.

- C. The Engineer reserves the right to direct the removal of any item which, in his opinion, does not present an orderly and reasonably neat or workmanlike appearance. Such removal and replacement shall be done when directed by the Engineer and without additional cost to the Owner.
- D. Mounting heights, unless otherwise noted, are to the finished bottom of the device.

3.4 STORAGE AND PROTECTION OF MATERIALS

- A. During construction, all equipment shall be properly protected against damage, defacing and freezing with shipping cartons, plastic sheeting, shipping covers, etc.
- B. All open ends of piping and equipment shall be sealed with nipples and caps, plugs, test plugs until final connection to system is made.
- C. All equipment and piping shall be protected to prevent entrance of foreign matter and debris by covering exposed openings during construction.
- D. Handle and store materials in accordance with manufacturer's and supplier's recommendations and in manner to prevent damage to materials during storage and handling. Replace damaged materials.
- E. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.5 EXCAVATION, TRENCHING & BACKFILLING

- A. The Contractor shall perform all excavation to install the work herein specified and as indicated on the Drawings. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. All excavated materials not to be used for backfill shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and others excavation and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut. No tunneling or boring shall be done except under pavement.
- B. The bottom of the trenches shall be graded to provide uniform bearing and support for conduits, cables, or duct bank on undisturbed soil at every point along its entire length. Overdepths shall be backfilled with loose, granular, moist earth, and tamped in 12" layers. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.
- C. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and tamped until the crown of the pipe is covered by a minimum of 6" of tamped earth. The backfill under and beside the pipe shall be compacted for pipe support. Backfill shall be brought up evenly on both sides of the pipe so that the pipe remains aligned. In instances where the manufacturer's

installation instructions for materials are more restrictive than those prescribed by the code, the material shall be installed in accordance with the more restrictive requirement. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. The compaction of the filled trench shall be at least equal to 95% of the maximum density as determined by the Standard Proctor Test. Settling the backfill with water will not be permitted. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore the surface to the grade and compaction indicated, mounded over and smoothed off. A metallic lined underground warning tape shall be provided 12" below finished grade. The tape shall be identified as to the type of line per ANSI standard nomenclature and color.

- D. Provide a layer of sand at least 6" deep under all plastic pipe installed in soil. Bell holes shall be excavated to ensure that the sewer pipe rests for its entire length upon a solid trench bottom.
- E. Tracer wires shall be installed adjacent to nonmetallic underground water, gas and main sewage lines under the building pad and stubbed up into a ground test well enclosure so that the tracer can connect to it. Tracer wire shall be color coded; yellow for natural gas; green for storm and sanitary sewer; and blue for potable water.
 - 1. Installation:
 - a. Trace wire shall be installed in the same trench and inside bored holes and casing with pipe during pipe installation. It shall be secured to the pipe as required to insure that the wire remains adjacent to the pipe. The trace wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all trace wire access points.
 - b. Except for approved spliced-in repair or replacement connections, tracer wire shall be continuous and without splices from each trace wire access point.
 - c. The tracer wire system shall be installed as a continuous single wire. No looping or coiling of wire is allowed.
 - d. Prior to backfill, install tracer wire on top of pipe and secure in place with ties or hitches at maximum 10-foot intervals in accordance with the Water Utilities Manual. Run tracer wire continuously along pipe and terminate in access points. Only adjacent valve boxes are acceptable access points. Where buried splices occur, use an electrical splicing kit 3M Brand DBR Direct Bury Splice Kit, or AGENCY approved equal. Provide no less than 24 inches of coiled wire at access points for attachment of pipe locating equipment. Each installed run of pipe shall be capable of being located using the tracer wire. Protect wire insulation from damage during installation and backfilling. Wire insulation that is broken, cut, or damaged shall be replaced.
 - e. At the point of connection between existing conductive pipes, the tracer wire shall not be connected to the iron pipe. This circumstance shall be treated as a mainline dead-end grounded using an approved waterproof connection to a grounding anode, buried at the same depth as the tracer wire. All such connection points shall be grounded.
 - f. Where existing tracer wire is encountered on an existing utility that is being extended or tied into, the new and existing tracer wire shall be connected using approved splice connectors, shall be properly grounded at the splice location as specified, and shall be completely waterproof to prohibit corrosion and loss of conductivity.
 - g. Tracer wire shall be laid flat and securely affixed to the pipe at the three o'clock position. The wire shall be protected from damage during the execution of the works. No breaks or cuts in the tracer wire or tracer wire

- insulation shall be permitted. At service saddles, the tracer wire shall not be allowed to be placed between the saddle and the main.
- h. At all main end caps, a minimum of 6 feet of tracer wire shall be extended beyond the end of the pipe, coiled and secured to the cap for future connections. The end of the tracer wire shall be spliced to the wire of a six pound zinc anode and is to be buried at the same elevations as the main. The tracer wire from the end cap shall be brought to a surface into test station box within the public right-of-way for future access.
 - i. Trace wire access points shall be accessible at all new water valve boxes. Concentrations of multiple proposed valves near pipe intersections, i.e. tees or crosses, may require more than one access point assembly in each concrete valve box collar.
 - j. At the point of connection between ductile iron water mains, with any non iron main, the tracer wire shall be properly connected to the iron pipe with a cad weld or approved equivalent. Tracer wire welds shall be completely sealed with the use of an approved mastic type sealer specifically manufactured for underground use. Mastic shall be applied in a thick coat a minimum of one quarter inch (1/4") thick and shall be protected from contamination by the backfill material with the use of a plastic membrane.
 - k. Trace wire systems must be installed as a single continuous wire, except where using approved connectors. No looping or coiling of wire is allowed.
 - l. Any damage occurring during installation of the trace wire must be immediately repaired by removing the damaged wire, and installing a new section of wire with approved connectors. Taping and/or spray coating shall not be allowed.
 - m. Open trench method:
 - 1) Tracer wire shall be placed a minimum of 8 inches above buried natural gas piping and nonmetallic piping for any service. For other utility piping systems tracer wire shall be laid directly upon pipe and attached at 8-10 ft. intervals with non-conductive tape. Additional attachment shall be provided at offsets and fittings in piping system. Tracer wire shall be placed carefully and great care shall be exercised during backfilling operations to maintain physical integrity and position relative to piping.
 - 2) Splices in tracer wire shall be kept to an absolute minimum. When splices are necessary they shall be made with tracer wire connectors as specified above. Other splicing methods not allowed.
 - n. Directional drilling method:
 - 1) Two tracer wires shall be provided with one wire as backup.
 - 2) Tracer wires shall be pulled through bore hole in conjunction with utility pipe. Wires shall be located on opposite sides of utility pipe.
 - 3) Tracer wire splices are not allowed in drilled sections.
 - o. Tracer wires shall be interconnected at intersections of mainlines and branches utilizing single three-way connector at each point of connection.
 - p. At a minimum, a terminal box shall be provided at each building utility service entrance and shall be located above piping within 5 ft. of point of entry into building.
 - q. Terminal boxes shall be located no greater than 1,000 linear feet of developed pipe length apart.

- r. Terminal boxes shall not be located in streets, drives, parking lots or other areas subject to vehicular traffic. Terminal boxes shall not be located in areas where access to box is impeded.
 - s. Terminal boxes shall be installed flush with finished grade and centered in grade level concrete pad. Concrete pad shall be 18" by 18" minimum and shall be 6" thick.
 - t. PVC pipe riser shall be firmly attached to bottom of terminal box housing and extended downward to an elevation approximately 12" above piping. Riser shall serve as a vertical conduit for guiding tracer wires into bottom of terminal box.
 - u. Care shall be taken to extend tracer wire from utility pipe to terminal box in an orderly manner as backfill is placed.
 - v. End of each tracer wire shall be properly landed on dedicated terminal within terminal box and securely tightened. 12-18" excess length shall be provided for each wire within box. Each terminal shall be clearly identified with permanent label. Where tracer wires for multiple utilities are terminated care shall be taken to ensure accuracy of identification at both ends.
2. Testing:
- a. All new trace wire installations shall be located using typical low frequency (512Hz) line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership.
 - b. This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project.
 - c. Final testing of each tracer wire shall be performed after backfill is complete and terminal boxes have been permanently installed and wires terminated. Test shall be witnessed by AE and Owner. It may be advisable for Contractor to perform preliminary test(s) during utility installation prior to final backfill and restoration. Testing shall be accomplished using typical low frequency line tracing equipment. Continuity testing in lieu of actual line tracing is not acceptable.
- F. Perform excavation and backfilling work in accordance with applicable portions of the earthwork section.

3.6 CONCRETE WORK

- A. Construct curbs, pads, vaults and similar supports for equipment where required.
- B. First floor and equipment yard: Provide minimum of 6" thick housekeeping pads at floor mounted equipment a minimum of 4" larger than the entire area occupied by equipment. The pads at the equipment yard must be elevated at 6" above finished floor (1st floor).
- C. Second floor and above: Provide 4" thick housekeeping pads at floor mounted equipment a minimum of 4" larger than the entire area occupied by equipment. Dowel pads to structural slab.
- D. Perform concrete work in accordance with applicable portions of Concrete sections. Minimum compressive strength of concrete shall be same as specified for slabs on grade.

3.7 CLEANING

- A. At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the job site.
- B. After all equipment has been installed, but prior to testing and balancing, all equipment, piping, etc. shall be thoroughly cleaned both inside and out.
- C. After testing and balancing of systems as specified and just prior to Owner review and acceptance, all systems shall be finally cleaned and shall be left ready for use.

3.8 TESTING OF PIPING SYSTEMS

- A. General
 - 1. All piping systems shall be subjected, before being insulated or concealed, to testing with water or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested required head or pressure shall be maintained until all joints are inspected.
 - 2. All tests shall be witnessed by the inspector having jurisdiction and the Owner's Representative, with a minimum 48-hour notice given these authorities.
 - 3. All equipment, material, labor and testing mediums required for testing any of the various systems or any part thereof shall be furnished by the Contractor.
 - 4. All connected equipment, accessories, etc. shall be isolated from piping systems prior to testing.
- B. Sanitary Piping Systems
 - 1. Water test shall be applied to these drainage systems either in their entirety or in sections as required, after rough piping has been installed. If the system is tested in sections, each opening shall be tightly closed except the highest opening in the section under test. All sections shall be tested with a minimum of 10 feet of head. In testing successive sections, at least the upper 10 feet of the next section shall be tested so that no joint of piping in the building shall be submitted to a test of less than 10 feet of head. The water shall be kept in the system for at least 30 minutes before inspection starts; the system shall then be made tight at all points.
 - 2. Any points of the drainage systems to be tested with air instead of water shall be made by attaching an air compressor testing apparatus to any suitable opening and after closing all other inlets or outlets, forcing air into the system until there is a minimum gauge pressure of 5 psi. This pressure shall be held without the introduction of additional air for a period of at least 30 minutes.
 - 3. Exterior connections shall be tested as part of the interior systems.
- C. Interior Water Piping Systems
 - 1. Upon completion of the entire water supply system or a section of it as required, it shall be tested prior to connection of fixtures and proved tight under a water/air pressure of 150 psi. Pressure shall hold for a period of one hour without introducing additional water/air. Water used for testing shall be from a potable source of supply. Defective joints or piping shall be replaced as required and all piping shall be retested.

D. Exterior Water Piping System

1. All exterior domestic water piping shall be tested to 150 psi for a period of two hours.

E. Defective Work

1. If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. All repairs to piping shall be made with new material. Caulking of screwed joints or holes is not acceptable.

F. Additional Tests

1. Provide all additional tests such as smoke or pressure tests as required by the regulations or as directed by authorities making the inspection.
2. Provide for any repeated test as directed by the Owner's Representative, to make all systems tight as required.
3. Visual inspections of joints, valves, etc. shall be made as directed by the Engineer.

3.9 DISINFECTION OF WATER SYSTEM - INTERIOR AND EXTERIOR

- A. Prior to project completion, all potable water piping systems shall be disinfected per local code requirements.
- B. Whenever the authority having jurisdiction does not specify disinfection procedures, the new water piping system shall be thoroughly disinfected with a solution containing not less than 50 parts per million of available chlorine. The chlorinating material shall be either liquid chlorine or sodium hydrochloride solution, shall be introduced into the system and drawn to all points in the system. The disinfection solution shall be allowed to remain in the system for a period of eight hours, during which period all valves and faucets shall be opened and closed several times. After disinfection, the solution shall be flushed from the system with clear water until the residual chlorine content is not greater than 0.2 parts per million.
- C. This work is to be supervised or performed by an approved chemical testing laboratory and results sent to Engineer or his representative for verification.

3.10 OPERATION AND MAINTENANCE MANUALS

- A. Form of Manuals:
 1. Prepare data in form of an instructional manual for use by Owner's personnel.
 2. Format:
 - a. Size: 8-1/2" x 11".
 - b. Text: Manufacturer's printed data or neatly typewritten
 3. Drawings:
 - a. Provide reinforced punched binder tab and bind in text.
 - b. Fold larger drawings to size of text pages.
 4. Provide fly leaf indexed tabs for each separate product or each piece of operating equipment
 5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
 - a. Title of Project
 - b. Identity of separate structures as applicable.
 - c. Identity of general subject matter covered in the manual

6. Binder as specified.
- B. Content of Manual:
 1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
 - a. Contractor, name of responsible principal, address and telephone number.
 - b. A list of each product required to be included, indexed to content of the volume.
 - c. List with each product, name, address and telephone number of:
 - 1) Subcontractor or installer
 - 2) Maintenance contractor as appropriate.
 - 3) Identify area of responsibility of each
 - 4) Local source of supply for parts and replacement
 - d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 2. Product Data:
 - a. Include those sheets pertinent to the specific product.
 - b. Annotate each sheet to:
 - 1) Identify specific product or part installed.
 - 2) Identify data applicable to installation.
 - 3) Delete references to inapplicable information. (All options not supplied with equipment shall be marked out indicated in some manner).
 3. Drawings:
 - a. Supplement product data with drawings as necessary to illustrate:
 - 1) Relations of component parts of equipment and systems.
 - 2) Control and flow diagrams.
 - b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
 - c. Do not use Project Record Documents as maintenance drawings.
 4. Written text, as required to supplement product data for the particular installation:
 - a. Organize in consistent format under separate headings for different procedures.
 - b. Provide logical sequence of instructions for each procedure.
 5. Copy of each warranty, bond and service contract issued.
 - a. Provide information sheet for Owner's personnel, giving:
 - 1) Proper procedures in event of failure.
 - 2) Instances that might affect validity of warranties or bonds
 6. Shop drawings, coordination drawings and product data as specified.
- C. Sections for Equipment and Systems
 1. Content for each unit of equipment and system as appropriate:
 - a. Description of unit and component parts
 - 1) Function, normal operating characteristics, and limiting conditions.
 - 2) Performance curves, engineering data and tests.
 - 3) Complete nomenclature and commercial number of replaceable parts
 - b. Operating procedures:
 - 1) Start up, break-in, routine and normal operating instructions.
 - 2) Regulation, control, stopping, shut down and emergency instructions.
 - 3) Summer and winter operating instructions.
 - 4) Special operating instructions

- c. Maintenance procedures:
 - 1) Routine operations
 - 2) Guide to trouble-shooting.
 - 3) Disassembly, repair and reassembly.
 - 4) Alignment, adjusting and checking.
 - 5) Routine service based on operating hours.
 - d. Servicing and lubrication schedule. List of lubricants required.
 - e. Manufacturer's printed operating and maintenance instructions.
 - f. Description of sequence of operation by control manufacturer
 - g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - 1) Predicted life of part subject to wear.
 - 2) Items recommended to be stocked as spare parts.
 - h. As installed control diagrams by controls manufacturer.
 - i. Complete equipment internal wiring diagrams.
 - j. Each Contractor's coordination drawings.
 - k. As installed color coded piping diagrams.
 - l. Charts of valve tag number, with location and function of each valve.
 - m. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
 - n. Other data as required under pertinent sections of the specifications.
- 2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
 - 3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications
 - 4. Provide complete information for products specified in Division 23.
 - 5. Provide certificates of compliance as specified in each related section.
 - 6. Provide start up reports as specified in each related section.
 - 7. Provide signed receipts for spare parts and material.
 - 8. Provide training report and certificates.
 - 9. Provide backflow preventer certified test reports.
 - 10. Provide gas piping pressure test report.

END OF SECTION 22 05 00

SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Expansion joints.
 - 2. Pipe alignment guides.
 - 3. Pipe anchors.
- B. Related Sections:
 - 1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for piping hangers and supports.

1.3 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.
- B. Expansion Compensation Design Criteria:
 - 1. Installation Temperature: 50 degrees Fahrenheit.
 - 2. Domestic Hot Water: 140 degrees Fahrenheit.
 - 3. Safety Factor: 30 percent.

1.4 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.
- C. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit calculations sealed by a registered professional engineer.
- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.

- H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- B. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.7 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years documented experience.
- B. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- B. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.9 WARRANTY

- A. Furnish five (5) year manufacturer warranty for leak free performance of packed expansion joints.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

- A. Manufacturers:
 - 1. Amber / Booth
 - 2. Triplex
 - 3. Mason Industries
 - 4. Uponor
- B. Stainless Steel Bellows Type:
 - 1. Pressure Rating: 200 psig WOG and 250 degrees Fahrenheit.
 - 2. Maximum Compression: 1-3/4 inch.
 - 3. Maximum Extension: 1/4 inch.
 - 4. Joint: As specified for pipe joints.
 - 5. Size: Use pipe sized units
 - 6. Application: Steel piping three (3) inch and smaller.

- C. External Ring Controlled Stainless Steel Bellows Type:
 - 1. Pressure Rating: 200 psig WOG and 250 degrees Fahrenheit.
 - 2. Maximum Compression: 15/16 inch.
 - 3. Maximum Extension: 5/16 inch.
 - 4. Maximum Offset: 1/8 inch.
 - 5. Joint: Flanged
 - 6. Size: Use pipe sized units
 - 7. Accessories: Internal flow liner.
 - 8. Application: Steel piping three (3) inch and larger.
- D. Double Sphere, Flexible Compensators:
 - 1. Body: Multi-layered Kevlar tire cord fabric reinforced with EPDM cover, liner and fabric frictioning with reinforcing ring.
 - 2. Working Pressure: 215 psi
 - 3. Maximum Temperature: 250 degrees Fahrenheit.
 - 4. Maximum Compression: 1-1/4 inch through 6 inch pipe; 1-1/2 inch 8 inch through 12 inch; 1-1/5 inch for 14 inch.
 - 5. Maximum Elongation: 3/4 inch through 6 inch pipe; 1-1/2 inch 8 inch through 12 inch; 5/8 inch for 14 inch.
 - 6. Maximum Offset: 3/8 inch through 6 inch pipe; 7/8 inch 8 inch through 12 inch; 1 inch for 14 inch.
 - 7. Maximum Angular Movement: 15 degrees.
 - 8. Joint: Steel flanges or ductile iron pipe flanges.
 - 9. Size: Use pipe sized units
 - 10. Accessories: Control rods.
 - 11. Application: Steel piping two (2) inch and larger.
- E. PEX-a Pipe Support (Uponor):
 - 1. For use with Uponor PEX-a pipe
 - 2. PEX-a pipe continuously supported with PEX-a Pipe Support and utilizing fixed anchor points every:
 - a. 65 feet for domestic hot water
 - b. 150 feet for domestic cold water
 - 3. Utilize the included stainless-steel straps to secure the PEX-a Pipe Support to the pipe at the intervals specified in the manufacturer's installation instructions.
 - 4. Refer to the Uponor Plumbing Design Assistance Manual for more information.

2.2 ACCESSORIES

- A. Manufacturers:
 - 1. Amber / Booth
 - 2. Triplex
 - 3. Mason Industries
- B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9.
- B. Rigidly anchor pipe to building structure to prevent stresses and transfer of loading to connected equipment.
- C. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 23 05 29 for pipe hanger installation requirements.
- D. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.
- E. Provide expansion loops as indicated on Drawings.
- F. Install expansion compensating devices for PEX tubing in accordance with the manufacturer's installation instructions.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 22 05 16

SECTION 22 05 29 - PLUMBING HANGERS AND SUPPORTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide a complete system of pipe hangers and supports for all plumbing and fire protection equipment and piping.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- B. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- C. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees Fahrenheit.
- B. Maintain this minimum temperature before, during, and for minimum three (3) days after installation of firestopping materials.

- C. Provide ventilation in areas to receive solvent cured materials.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
1. Unistrut Corp.
 2. Erico Caddy.
 3. PHP System.
 4. Anvil/Anvil Strut.
 5. BLINE.
- B. Pipe Supports:
1. Conform to MSS SP58.
 2. Hangers for Pipe sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
 3. Hangers for Pipe sizes two (2) inches and Larger: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe sizes three (3) inches and Smaller: Cast iron hook.
 6. Wall Support for Pipe sizes four (4) inches and Larger: Welded steel bracket and wrought steel clamp.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.
 10. PEX Tube Support: CTS sized hangers or supports free of sharp edges.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 SLEEVES AND ESCUTCHEONS

- A. The Contractor shall furnish and set pipe sleeves and inserts for all work under this section and shall be responsible for their proper and permanent location. In the event that failure to do so requires cutting and patching, the remedial work shall be the responsibility of the Contractor.
- B. All pipes passing through floors, walls or partitions shall be provided with sleeves having an internal diameter 1-1/2" (3/4" annular space) larger than the outside diameter of the pipe or insulation on covered lines, except as otherwise specified herein.
- C. Sleeves for Pipes through Non-fire Rated Floors and Walls: 18 gage thick galvanized steel. Sleeves for all pipes through walls, beams and partitions shall finish flush with the finish line of the walls, beams and partitions.

- D. Sleeves for all piping shall extend 1/2" above finish floor, (except where under partitions, the sleeves shall be flush with the bottom of the partition) and after the installation of pipe shall be packed and made watertight with fire stopping sealant to maintain separations and fire ratings.
- E. Where pipes pass under footings and through exterior walls, sleeves shall be of galvanized steel pipe and shall be not less than 4" larger than the pipe being sleeved. Sleeves shall be made watertight where passing through waterproofed surfaces, exterior wall, and floor slabs on grade. Waterproofing shall be done by means of a steel slip on welding flange, continuously welded at the center of the sleeve and shall be painted with one coat of bitumastic paint inside and outside. The space between sleeve and pipe shall be packed with oakum to within 2" of each face of the wall; (to within 2" of the top of sleeve at floors). The remaining space shall be packed and made watertight with a waterproof mastic. Mechanical expansion type rubber seals such as manufactured by Calpico Ind. and Thunderline Corporation are acceptable as alternate method of water proofing piping penetrations.
- F. Sleeves through floors or interior masonry walls shall be of galvanized steel pipe or wrought iron pipe size except where located in concealed pipe spaces where they may be of 22 gauge galvanized sheet steel if fire rating is maintained.
- G. Sleeves for piping to receive insulation shall be large enough to allow continuous insulation through sleeves.
- H. Spacing between or location of pipe sleeves in floor slabs, structural beams or structural walls shall be subject to the Structural Engineer's approval.
- I. Where pipes pass under load bearing footings they shall pass through a coated steel pipe sleeve as described above and extend past a 45 degree line out from the bottom of the load bearing structure. Concrete shall be used as backfill in the portions of trench within the 45 degree pressure line.
- J. Provide chrome plated escutcheon plates on pipes passing through walls, floors, and ceilings exposed to view. Escutcheons shall be of sufficient outside diameter to cover the sleeve opening and shall fit snugly around the insulated or bare pipe and to the wall, partition, floor or ceiling. Provide stainless steel sheet metal for exterior walls. Welded water ring sleeve shall be used on all exterior wall and floor penetrations.
- K. Sealant: Acrylic

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc., or approved equal.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Unistrut Corp., or approved equal.

- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.7 FIRESTOPPING

- A. Manufacturers:
1. Dow Corning Corp. Model.
 2. 3M fire Protection Products Model.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
 2. Foam Firestopping Compounds: Multiple component foam compound.
 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 7. Firestop Pillows: Formed mineral fiber pillows.
- C. Color: Dark gray Black As selected from manufacturer's full range of colors.
- D. Plastic Tube and Pipe: Ensure that the appropriate firestop assembly is used for plastic piping systems. Refer to manufacturer's system selector for more information.

2.8 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
1. Mineral fiberboard.
 2. Mineral fiber matting.
 3. Sheet metal.
 4. Plywood or particle board.
 5. Alumina silicate fire board.
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
1. Furnish UL listed products or products tested by independent testing laboratory.
 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing or damming materials to arrest liquid material leakage.
- D. Do not drill or cut structural members.
- E. Do not crush insulation with pipe clamp. Provide high density pipe insulation to accommodate pipe clamp or hanger.
- F. Do not attach beam clamp on to bottom of steel joist.

3.2 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe four (4) inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with MSS SP 58.
- B. Supports for Gas Piping:
 - 1. Horizontal supports for steel and copper gas piping, threaded or welded, are every six (6) feet for 1/2 inch, every eight (8) feet for 3/4 inch and one (1) inch, and every ten (10) feet for 1-1/4 inches or larger.
 - 2. Vertical supports for steel gas piping, threaded or welded, are every six (6) feet for 1/2 inch, eight (8) feet for 3/4 inch and one (1) inch, and every floor for 1-1/4 inch and larger.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with five (5) feet maximum spacing between hangers. Support hubless cast iron at every other joint unless over four (4) feet then support at each joint. Support copper every six (6) feet for 1-1/2 inch and smaller; every ten (10) feet for two (2) inches and larger.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation.
- L. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- M. Support PEX tubing every 32 inches unless a continuous support such as Uponor PEX-a Pipe Support is used. Then:
 - 1. 1/2 - 3/4 inch pipe: 6 feet
 - 2. 1 – 3 inch pipe: 8 feet
- N. Install PEX tubing in accordance with the Uponor Plumbing Design Assistance Manual or the Uponor Professional Plumbing Installation Guide.

3.4 INSTALLATION - SLEEVES

- A. Exterior watertight entries, such as grade beam, basement wall, sump wall etc.: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors one (1) inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation or caulk. Firestopping required at all penetrations of rated floor and walls.
- F. Install chrome plated steel escutcheons at finished surfaces.

3.5 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating. Refer to Architectural drawings for location of all rated walls and floors.
- D. Fire Rated Surface:
 - 1. Seal opening at floor and wall as follows:

- a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
- E. Non-Rated Surfaces:
- 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Install type of sealant or caulk suitable for application.
 - 2. Install escutcheons where pipe, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

END OF SECTION 22 05 29

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SECTION 22 05 00 – COMMON WORK RESULT FOR PLUMBING
- C. SECTION 22 05 48 – EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING
- D. SECTION 22 05 29 – PLUMBING PIPE HANGERS AND SUPPORTS
- E. SECTION 22 05 48 – VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
- F. SECTION 22 05 48.13 – VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

1.3 SUMMARY

- A. Provide a complete domestic water piping system.
- B. Provide pressure gauge with all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, and leave in safe and proper operating condition all systems.
- C. All materials and equipment for the potable water system shall meet the latest mandates and requirements for lead free required by law that goes into effect January 2014.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Gauge: Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and manufacturer instruction.
 - 4. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.7 EXTRA MATERIALS

- A. Furnish two (2) packing kits for each size valve and two (2) loose keys for outside hydrants.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

- A. Products and materials listed herein are for references of approved materials.
- B. Unless noted otherwise, the contract documents (schedule sheet) will specify the products and materials that are to be used for this project.

2.2 WATER PIPING, BELOW GRADE

- A. Copper Tubing: ASTM B88, Type K.
 - 1. Fittings: ASME B16.22 wrought copper and bronze.
 - 2. Joints: AWS A5.8, BCuP silver braze.

2.3 WATER PIPING, ABOVE GRADE

- A. Copper Tubing 4" and smaller: ASTM B88, Type L hard drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5TA (tin-antimony), or tin and silver, with melting range 430 to 535 degrees F. [Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.]
 - 3. At the contractor's option, Press connection copper fittings manufactured by NIBCO INC. or approved equal will be acceptable. Building services piping -20 degrees to +250 degrees up to 200 PSI. Fittings shall comply with NSF-61, CSA, UPC. Seals shall be made of EPDM material and manufactured with an inboard bead design. The fittings shall include the Smart Connect feature to identify unpressed connections during system testing. All fittings shall be installed in accordance with the manufacturer's installation instructions and according to local plumbing and mechanical codes.

2.4 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size two (2) inches and Smaller:
 - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Pipe Size 2-1/2 inches and Larger:
 - 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets (Victaulic split ring flange is not allow).
 - 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
 - 3. PEX-a tube and pipe: Class 150 ASME B16.5 flanges; ASTM F1960 joints.
- C. Dielectric Connections:
 - 1. Two (2) inches and smaller union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
 - 2. 2-1/2 inches and larger, forged steel flanges, screwed neck, 1/16 inch thick performed neoprene gasket. (Same as paragraph B, above.)

2.5 VALVES

A. General

1. Valves shall be located to permit easy operation, replacement and repair. They shall be installed where shown on the Drawings, or as herein specified.
2. Control valves shall be provided for the domestic hot and cold water supply to all risers and specific areas such as restrooms, fixture groups, equipment, hose bibbs and wall hydrants, food service areas and building separations. Valves shall be located in back-of-house or service areas with access panels or above lay-in ceilings. No access panels will be permitted in public spaces with gypsum ceilings.

B. Ball Valves:

1. Manufacturers:
 - a. NIBCO INC.
 - b. Milwaukee.
 - c. Apollo.
 - d. Bray.
 - e. Kitz.
2. Two (2) inches and Smaller: NIBCO INC., S/T-585-80-LF, full-port, MSS SP 110, Class 150, 600 psi CWP, silicon bronze, two piece body, chrome plated silicon bronze ball, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder or threaded ends. No Lead.
3. Where piping is insulated, ball valves shall be equipped with two (2) inch extended handles of non-thermal conductive CPVC material that meets UL 2043 approved for inside air plenum. Also provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Memory stops, which are fully adjustable after insulation is applied, shall be included.
4. Ball valves installed outdoors or in-ground shall have stainless steel handle.
5. Ball Valves for PEX-a Two (2) inches and smaller: NSF 359, Class 150, 250 psi CWP, forged brass, two piece body, brass ball, Teflon (PTFE) seats, blow-out proof stem, lever handle, ASTM F1960 ends. No Lead. Basis of design Uponor Lead-free Commercial Ball Valves.
6. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.
7. Provide memory stops on all ball valves installed in domestic hot water return lines. Memory stops shall be adjustable after pipe insulation is applied.

C. Shut-off Valves:

1. Manufacturers:
 - a. NIBCO INC.
 - b. Milwaukee.
 - c. Apollo.
 - d. Bray.
 - e. Kitz.
2. Line Shut-Off Valves 2-1/2" and larger where system operating pressure will not exceed 160 p.s.i.g. shall be 200 WOG threaded lug type ductile iron body butterfly valve with extended neck, lockable lever handle, 416 stainless steel stem, aluminum bronze disc, EPDM liner and seal, suitable for bi-directional flow and dead end service with downstream flange removed. Acceptable valves are NIBCO Model LD-2000, or approved equivalent model by Keystone, Jamesbury, Milwaukee, Crane or Apollo.
3. Line Shut-Off Valves 2-1/2" and larger installed within systems having design operating pressures between 160 and 250 p.s.i.g. shall be threaded lug type

ductile iron body butterfly valve with extended neck, lockable lever handle, 316 stainless steel stem and disc, EPDM liner and seal, suitable for bi-directional flow and dead end service with downstream flange removed. Acceptable valves are NIBCO Model LD-3022, or approved equivalent model by Keystone, Jamesbury, Dezurik, Milwaukee, Crane or Apollo.

4. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.
- D. Swing Check Valves:
1. Manufacturers:
 - a. NIBCO INC.
 - b. Milwaukee.
 - c. Apollo.
 - d. Kitz.
 2. Two (2) inches and Smaller: Nibco S-413-LF Series, class 125, MSS SP 80, silicon bronze body, stainless steel and PTFE disc, and soldered ends. No Lead.
 3. 2-1/2 inches and Larger: NIBCO INC. F918-SS Series, MSS SP 71, cast iron body, stainless steel fitted, stainless steel disc, flanged ends. No Lead.
- E. Balancing Valves (Hot Water Recirculation)
1. Balancing valves shall be venturi orifice type, bronze or brass body with brass or chrome ball, a minimum of two differential pressure read-out ports, 300 psi minimum working pressure. A compatible positive shutoff ball valve with memory stop is to be provided if not included with the balancing valve assembly.
 2. Balancing valves shall be Flow Design Incorporated (FDI) model AC or MC or approved equal by ITT or Bell and Gossett.
 3. Ball valves are not acceptable for balancing the hot water return system.

2.6 RELIEF VALVES

- A. Manufacturers: Watts Industries, or approved equal.
- B. Temperature and Pressure Relief:
1. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees Fahrenheit, capacity ASME Section IV certified and labeled.
- C. Vacuum Relief Valves:
1. Watts N36 Lead Free Series.

2.7 STRAINERS

- A. Manufacturer: NIBCO INC., Mueller Steam Specialty, or approved equal.
- B. Two (2) inches and Smaller: Threaded bronze body for 200 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen. NIBCO INC., 221 Series.
- C. 2-1/2 and Larger: Class 125, flanged iron body, Y pattern with 1/16-inch stainless steel perforated screen. NIBCO INC., F-271 Series.
- D. Lead Free.

2.8 GAGES AND TAPS

- A. Manufacturers: For portable water system (Lead Free)
 - 1. Weiss
 - 2. Marsh Bellofram
 - 3. Weksler
 - 4. Dwyer
- B. Gage: ASME B40.1, UL 404 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - 1. Case: Stainless steel.
 - 2. Bourdon Tube: Phosphor bronze.
 - 3. Dial Size: 4-1/2 diameter.
 - 4. Mid-Scale Accuracy: One (1) percent.
 - 5. Scale: Psi.
- C. Needle Valve: Brass, 1/4 inch NPT for minimum 300 psi.
- D. Ball Valve: Brass 1/4 inch NPT for 250 psi.
- E. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.
- F. Siphon: Brass, 1/4 inch NPT angle or straight pattern.

2.9 SLEEVES AND ESCUTCHEONS

- A. The Contractor shall furnish and set pipe sleeves and inserts for all work under this section and shall be responsible for their proper and permanent location. In the event that failure to do so requires cutting and patching, the remedial work shall be the responsibility of the Contractor.
- B. All pipes passing through floors, walls or partitions shall be provided with sleeves having an internal diameter 1-1/2" (3/4" annular space) larger than the outside diameter of the pipe or insulation on covered lines, except as otherwise specified herein.
- C. Sleeves for all pipes through walls, beams and partitions shall finish flush with the finish line of the walls, beams and partitions.
- D. Sleeves for all piping shall extend 1/2" above finish floor, (except where under partitions, the sleeves shall be flush with the bottom of the partition) and after the installation of pipe shall be packed and made watertight with fire stopping sealant to maintain separations and fire ratings.
- E. Where pipes pass under footings and through exterior walls, sleeves shall be of galvanized steel pipe and shall be not less than 4" larger than the pipe being sleeved. Sleeves shall be made watertight where passing through waterproofed surfaces, exterior wall, and floor slabs on grade. Waterproofing shall be done by means of a steel slip on welding flange, continuously welded at the center of the sleeve and shall be painted with one coat of bitumastic paint inside and outside. The space between sleeve and pipe shall be packed with oakum to within 2" of each face of the wall; (to within 2" of the top of sleeve at floors). The remaining space shall be packed and made watertight with a waterproof mastic. Mechanical expansion type rubber seals

such as manufactured by Calpico Ind. and Thunderline Corporation are acceptable as alternate method of water proofing piping penetrations.

- F. Sleeves through floors or interior masonry walls shall be of galvanized steel pipe or wrought iron pipe size except where located in concealed pipe spaces where they may be of 22 gauge galvanized sheet steel if fire rating is maintained.
- G. Sleeves through interior masonry partitions shall be of 22-gauge galvanized sheet steel.
- H. Sleeves for piping to receive insulation shall be large enough to allow continuous insulation through sleeves.
- I. Spacing between or location of pipe sleeves in floor slabs, structural beams or structural walls shall be subject to the Structural Engineer's approval.
- J. Where pipes pass under load bearing footings they shall pass through a coated steel pipe sleeve as described above and extend past a 45 degree line out from the bottom of the load bearing structure. Concrete shall be used as backfill in the portions of trench within the 45 degree pressure line.
- K. Escutcheons shall be provided around all exposed pipe passing through walls, partitions, ceilings and floors in finished spaces. Escutcheons shall be of sufficient outside diameter to cover the sleeve opening and shall fit snugly around the insulated or bare pipe and to the wall, partition, floor or ceiling.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than two (2) feet of cover.
- C. Establish minimum separation from other services piping in accordance with code.
- D. Remove scale and dirt on inside of piping before assembly.
- E. Install pipe on prepared bedding.
- F. Route pipe in straight line.
- G. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- H. Do not use lead bearing solder materials.

- I. Pipe Cover and Backfilling:
 - 1. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in four (4) inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 2. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 3. Do not use wheeled or tracked vehicles for tamping.
- J. Provide tracer wire for all piping routed below slab locate wire leads in accessible location for use in future line trouble shooting.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. Insulate all piping installed in exterior walls, above food service areas, and any area exposed to temperatures below 40 degrees Fahrenheit.
- B. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Insulate all domestic hot water supply and return lines.
- D. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
- G. Provide expansion tank for each domestic water heater, install per manufacturer's recommendations.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 05 29.
- I. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Architect.
- J. Establish elevations of buried piping outside the building to obtain not less than one (1) foot of cover.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Install water piping in accordance with ASME B31.9.
- M. Sleeve pipes passing through partitions, walls and floors.
- N. Install unions downstream of valves and at equipment or apparatus connections.
- O. Install valves with stems upright or horizontal, not inverted.
- P. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

- Q. Install ball valves for shut-off and to isolate equipment at branch to each fixture bank and at each plumbing appliance or water heater.
- R. Provide check valves on discharge of all water circulating pumps.
- S. Install potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- T. Pipe relief from valves, back-flow preventers and drains to nearest floor drain.
- U. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to all equipment with solenoid valves. Coordinate size and location of access doors with Architect.
- V. Route all domestic water piping inside building in climate controlled space not subject to freezing.
- W. Do not use lead bearing solder materials.
- X. In natatorium, including equipment rooms, all exposed plumbing piping shall be insulated and protected by a complete aluminum jacketing system. Refer to Section 23 07 16 for specification on jacketing. Provide color coded, printed pipe label 10' on center identifying pipe service type (gas, domestic water, storm water, etc.).
- Y. Press-Connect Joints for Copper Tubing: Join copper tube and press-connect fittings with tools recommended by fitting manufacturer.
- Z. Lead Free.

3.5 INSTALLATION - SERVICE CONNECTIONS

- A. At each incoming water service line provide approved reduced pressure back-flow preventer.
- B. Provide a cast iron sleeve around service main to six (6) inches above floor and six (6) inches minimum below grade beam. Size for minimum of two (2) inches of loose batt insulation stuffing.
- C. Optionally, where building structural components permit, water service entrance may be composed of a single extended 90 degree fitting of fabricated 304 stainless steel tubing, maximum Working pressure of 175 psi with grooved-end connection on the outlet (building) side and a cast iron pipe size coupler on the underground (inlet) side.

3.6 INSTALLATION - BACKFLOW PREVENTERS

- A. Provide at each make up connection to a hot water boiler, cooling tower, chilled water system, kitchen equipment, and at each piece of equipment requiring a make-up connection.
- B. Provide at water supply to fire protection system.
- C. Provide a floor drain within six (6) feet of each backflow preventer.

- D. Backflow preventer shall be certified by Contractor.
- E. Lead Free.

3.7 INSTALLATION – PRESSURE GAGES

- A. Install pressure gages for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- B. Install gage taps in piping with isolation valves.
- C. Install pressure gages at main water entry. Provide needle valve or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install gage in piping to each inlet and outlet of water heater.
- E. Install gage in piping to each end of backflow preventer.
- F. Install gage in piping to each end of double check valves.
- G. Install gage in piping to each inlet and outlet of water softener.
- H. Install gage in piping to each inlet of water filter.
- I. Install gage in piping to each inlet of commercial dishwasher machine.

3.8 DOMESTIC HOT WATER SYSTEM BALANCING

- A. The test and balance contractor shall provide testing, adjusting and balancing of the hot water system, once the system is fully installed and operational. Preliminary and final reports shall be prepared and issued to the General Contractor, Architect and Engineer.
- B. Preparation of the hot water system for balancing:
 - 1. Confirm outlet temperature of the system at water heaters and/or storage tanks.
 - 2. Verify recirculation pump operation and rotation.
 - 3. Confirm/adjust setpoint of each individual riser balancing valve to flow a minimum of 0.5 gpm or as otherwise noted on the documents.
- C. The test and balance report shall indicate the following:
 - 1. Pressure, temperature and flow in gpm at the discharge side of each balancing valve referencing the valve tag number.
 - 2. Pressure, temperature and flow in gpm at the suction side of each recirculating pump.
- D. Copies of the final approved balancing report are to be included in the O and M manuals as noted in "Permits" under Part 1 of Section 22 00 00.

3.9 FIELD QUALITY CONTROL

- A. Pressure test all domestic water piping.
- B. After installation and prior to backfill or cover-up, rinse piping system of particulate contaminants, cap and subject to static water pressure of 125 psig for four (4) hours.
- C. Repair leaks and defects and re-test any portion of piping system that fails.
- D. Provide written test report including date and time of test, pass or fail indication, summary of remedial work required and date and time of each re-test.

END OF SECTION 22 11 16

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SECTION 22 05 00 – COMMON WORK RESULT FOR PLUMBING
- C. SECTION 22 05 48 – EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING
- D. SECTION 22 05 29 – PLUMBING PIPE HANGERS AND SUPPORTS
- E. SECTION 22 05 48 – VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
- F. SECTION 22 05 48.13 – VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

1.3 SUMMARY

- A. Provide a complete sanitary drainage system.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
- B. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of equipment and clean-outs.
- B. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include spare parts lists, exploded assembly views for pumps and equipment.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with the plumbing code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

- A. Products and materials listed herein are for references of approved materials.
- B. Unless noted otherwise, the contract documents (schedule sheet) will specify the products and materials that are to be used for this project.

2.2 SANITARY SEWER PIPING, BELOW GRADE

- A. PVC Pipe
 - 1. Provide a complete system of solid wall schedule 40 PVC DWV piping with solvent welded joints.
 - 2. Solvent welded joints shall conform to IAPMP installation standards IS-9.
 - 3. Provide tracer wire at all underslab piping at exit point from building slab. Wire to be 12AWG, yellow insulation, and copper conductor. Provide cast junction box flush with finished grade permanently labeled "Tracer Wire". Extend wire from exit point around all non-metallic piping to properly line, coordinate installation with Civil contractor.
 - 4. Pipe and fittings shall conform to ASTM D 1784, AST D 1785, ASTM D 2665, ASTM D 3311, and NPS standard 14 & 61.
- B. Cast Iron Pipe: ASTM A888 and CISPI 301, hub-less, service weight and marked with the collective trademark of the CISPI and listed by NSF International (first 15'-0" section of dishwasher waste, grease waste pipe, and any other discharge piping having the potential of 140 degree or greater):
 - 1. Fittings: No hub cast iron fittings per CISPI 301 and ASTM A888.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies conforming to ASTM D564. Heavy duty couplings are required on no-hub systems at the base of stack and vertical to horizontal offsets and shall conform to the requirements of ASTM C1540 and shall be type 304 stainless steel shielded couplings with stainless steel worm gear clamps, 15 psi working pressure.
 - a. Acceptable Manufacturers: Clamp-All High Torq 125 or Husky SD-4000.

2.3 SANITARY SEWER PIPING, ABOVE GRADE

- A. Manufacturers
 - 1. AB&I
 - 2. Charlotte Pipe and Foundry Co.
 - 3. Tyler Pipe/Soil Division
- B. Cast Iron Pipe: ASTM A888 and CISPI 301, hub-less, service weight and marked with the collective trademark of the CISPI and listed by NSF International.
 - 1. Fittings: No hub cast iron fittings per CISPI 301 and ASTM A888.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies conforming to ASTM D564. Heavy duty couplings are required on no-hub systems at the base of stack and vertical to horizontal offsets and shall conform to the requirements of ASTM C1540 and shall be type 304 stainless steel

shielded couplings with stainless steel worm gear clamps, 15 psi working pressure.

- a. Acceptable Manufacturers: Clamp-All High Torq 125 or Husky SD-4000.
3. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies conforming to ASTM D564. Medium duty couplings are required on no-hub systems excluding at the base of stack and vertical to horizontal offsets and shall conform to the requirements of ASTM C1540 and shall be type 304 stainless steel shielded couplings with stainless steel worm gear clamps, 15 psi working pressure.
 - a. Acceptable Manufacturers: Tyler Wide Body or Husky HD-2000.
4. Transition coupling: No hub cast iron pipe to PVC use Proflex coupling by Fernco.

2.4 VENT PIPING, ABOVE GRADE

- A. Manufacturers
 1. AB&I
 2. Charlotte Pipe and Foundry Co.
 3. Tyler Pipe/Soil Division
- B. Provide no-hub cast iron pipe and fittings.
- C. No-hub cast shall conform to requirements of ASTM A 74.

2.5 VENT PIPING, BELOW GRADE

- A. Use same as Sanitary Sewer Piping, Below Grade.

PART 3 - EXECUTION

3.1 FLOOR DRAINS

- A. Provide floor drain, including sanitary waste and vent piping, where indicated on drawings and at each toilet room containing two (2) or more water closets or a combination of one (1) water closet and one (1) urinal.
- B. Coordinate the exact location of all floor drains with Architectural Drawings prior to rough-in. Ensure drains are located at low points(s) of floor slope.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Coordinate the exact location of all floor drains with architectural drawings prior to rough-in. Ensure drains are located at low point(s) of floor slope.
- C. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert as indicated on Drawings.
- B. Establish minimum separation from other services piping in accordance with code.

- C. Remove scale and dirt on inside of piping before assembly.
- D. Install with a uniform slope of not less than 1/4 of an inch per foot.
- E. Install pipe on prepared bedding of bank sand, minimum of 2" depth on bottom of trench up to centerline of pipe.
- F. Route pipe in straight line.
- G. Excavation:
 - 1. Excavate trenches for underground piping to the required depth to ensure two (2) foot minimum coverage over piping.
 - 2. Cut the bottom of the trench or excavation to uniform grade.
 - 3. Lay out alignment of pipe trenches to avoid obstructions. Assure that proposed route of pipe will not interfere with building foundation before any cutting is begun. Should interference be found, contact the Architect/Engineer before proceeding.
- H. Pipe Cover and Backfilling:
 - 1. Backfill shall not be placed until the work has been inspected, tested, and approved. Complete backfill to the surface of natural ground or to the lines and grades shown on drawings. Except where special materials are requested, use suitable friable soils from other excavation as backfill material. Do not use peat, silt, muck, debris or other organic materials. Deposit backfill in uniform layers and compact each layer as specified in Division 2.
 - 2. Compacting Backfill. Place material in uniform layers of prescribed maximum thickness and wet or dry the material to optimum moisture content. Compact with power-driven tampers to the prescribed density. Place regular backfill in eight (8) inch maximum layers, loose measure. Compact to not less than 95% of maximum soil density as determined by ASTM D-698 Standard Proctor.
 - 3. Restoration. Compact backfill, where trenching or excavation is required in improved areas such as pavements, walks, and similar areas, to a condition equal to the adjacent undisturbed earth, and restore surface of the area to the condition existing prior to trenching or excavating operation.
- I. Disposal of excess material:
 - 1. Remove excess excavation material or material unsuitable for backfill. Excess material can be spread on grade, or shall be removed from site as directed by Owner/Architect.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one (1) percent) minimum. Maintain gradients.
- B. Furnish and install cleanouts in soil and waste lines as required by Code and/or job conditions, as shown on the Drawings and as follows: At or near the end of each branch and main drainage line, horizontal lines at intervals as required by code. All cleanouts shall be readily accessible, with plugs easily removable for cleanout lines. Cleanouts at the base of vertical piping shall be held within 2'-0" from finished floor unless otherwise indicated.
- C. Install a floor clean out according to the following;
 - 1. Not more than 40' apart in all horizontal drain lines.
 - 2. At each change of direction greater than 45 Deg.

3. At the base of each waste or soil stack.
 4. Install floor cleanouts at elevation to accommodate finished floor.
 5. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.
 6. Provide Wye cleanouts with long sweeps turned up to elevated floor conditions for cleanout openings at floor drain waist lines.
- D. Install a wall cleanout according to the following:
1. Install a wall cleanout at every sanitary piping within wet wall chase for all urinals. Wall cleanout shall be flush with exterior side of wall
 2. Provide full size wall cleanouts at end of run and on soil stack at ganged toilets where pipes penetrate the slab including water closets, lavatories and EDF's.
- E. Install a exterior cleanout according to the following:
1. Encase exterior cleanouts in concrete flush with grade.
 2. Provide double cleanouts where building sanitary sewer system and civil sewage system intersect.
- F. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- G. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- H. Install piping to maintain headroom. Do not spread piping, conserve space.
- I. Group piping whenever practical at common elevations.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation.
- L. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Architect.
- M. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- O. Burred ends of all pipe and tubing shall be reamed to the bore of the pipe or tube and all chips shall be removed before installation.
- P. Install bell and spigot pipe with bell end upstream.
- Q. Sleeve pipes passing through partitions, walls and floors.
- R. Support cast iron drainage piping at every joint.
- S. Water test all piping per code.

- T. Insulate all above slab horizontal sanitary waste piping carrying air-conditioning condensate with fiberglass insulation with jacket from floor drain, including traps, all the way to change in direction to vertical.
- U. Slope all vent piping to allow for drainage.
- V. Provide and install a floor sink next to each HVAC air handling unit, pump, expansion tank, and every piece of HVAC equipment requiring condensate removal in every mechanical room.
- W. Drainage-waste-vent copper pipe and fittings for waste stub-outs for all fixture locations.

3.5 RODDING SEWERS

- A. All sanitary soil and waste lines, both in the building and out, shall be rodded out after completions of the installation.
- B. This Work shall be done, as part of the contract, to make certain that all lines are clear, and any obstruction that may be discovered shall be removed immediately. Rodding shall be accomplished by utilizing a rotary cutter, which shall be full size of pipe being cleaned. Rodding operations shall be witnessed by Owner's field representative. Submit a certificate of completion to owner.

3.6 FIELD QUALITY CONTROL

- A. Separate trenches for water lines, sanitary, storm, and gas piping.
- B. Piping shall be labeled along entire length; indicating size, class, material specification, manufacturers name, and country of origin.
- C. Piping and fittings resting on ground is unacceptable. Keep products covered. Provide temporary end caps and closures on piping and fittings.
- D. Foreign pipe and fittings unacceptable.
- E. Prior to cover up water pipe, sanitary pipe, and gas piping shall be pressure tested. Tests shall be witnessed by consultant and owner. Notify owner 48 hours prior to test. Test shall be witnessed by client plumbing technician.
- F. The inside of all sanitary lines shall be video recorded with a camera and witnessed by owner to first outside manhole. Provide tape and/or DVD upon closeout of project. If any obstructions are found they shall be removed and the line shall be videoed again to show the blockage has been cleared.
- G. For additions and renovations, use camera to locate routing of underslab lines.
- H. Upon completion of the sanitary piping system, the contractor shall notify engineer and owner to observe a smoke test of the system. Smoke testing shall be performed on sanitary piping system twice during construction.

END OF SECTION 22 13 16

SECTION 22 14 13 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. SECTION 22 05 00 – COMMON WORK RESULT FOR PLUMBING
- C. SECTION 22 05 48 – EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING
- D. SECTION 22 05 29 – PLUMBING PIPE HANGERS AND SUPPORTS
- E. SECTION 22 05 48 – VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
- F. SECTION 22 05 48.13 – VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

1.2 SUMMARY

- A. Provide a complete storm drainage piping system.
- B. Section Includes:
 - 1. Storm Piping Below Grade
 - 2. Storm Piping Above Grade

1.3 SUBMITTALS

- A. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
- B. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Products and materials listed herein are for references of approved materials.
- B. Unless noted otherwise, the contract documents (schedule sheet) will specify the products and materials that are to be used for this project.

2.2 STORM WATER PIPING, BELOW GRADE

- A. PVC Pipe
 - 1. Provide a complete system of solid wall schedule 40 PVC DWV piping with solvent welded joints.
 - 2. Provide tracer wire at all underslab piping at exit point from building slab. Wire to be 12AWG, yellow insulation, and copper conductor. Provide cast junction box flush with finished grade permanently labeled "Tracer Wire". Extend wire from exit point around all non-metallic piping to properly line, coordinate installation with Civil contractor.
- B. Contractor Option: Provide a complete system of schedule 40 PVC with solvent welded joints.
- C. Foam core PVC piping is not acceptable for any drainage system.

2.3 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A888 and CISPI 301, hub-less, service weight and marked with the collective trademark of the CISPI and listed by NSF International.
 - 1. Fittings: No hub cast iron fittings per CISPI 301 and ASTM A888.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies conforming to ASTM D564. Heavy duty couplings are required on no-hub systems at the base of stack and vertical to horizontal offsets and shall conform to the requirements of ASTM C1540 and shall be type 304 stainless steel shielded couplings with stainless steel worm gear clamps, 15 psi working pressure.
 - a. Acceptable Manufacturers: Clamp-All High Torq 125 or Husky HD-4000.
 - 3. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies conforming to ASTM D564. Medium duty couplings are required on no-hub systems excluding at the base of stack and vertical to horizontal offsets and shall conform to the requirements of ASTM C1540 and shall be type 304 stainless steel shielded couplings with stainless steel worm gear clamps, 15 psi working pressure.
 - a. Acceptable Manufacturers: Tyler Wide Body or Husky HD-2000.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than two (2) feet of cover.
- C. Establish minimum separation from other services piping in accordance with code.
- D. Remove scale and dirt on inside of piping before assembly.
- E. Install pipe with uniform slope of not less than 1/8 of an inch per foot.
- F. Install pipe on prepared bedding of bank sand, minimum of 2" depth on bottom of trench up to centerline of pipe.
- G. Route pipe in straight line.
- H. Pipe Cover and Backfilling:
 - 1. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in four (4) inches compacted layers to 12 inches minimum cover over top of pipe.
 - 2. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 3. Do not use wheeled or tracked vehicles for tamping.

3.3 INSTALLATION - ABOVE GROUND PIPING

- A. Establish invert elevations, slopes for drainage 1/8 inch per foot (one (1) percent) minimum. Maintain gradients.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearance at cleanout for snaking drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom. Group piping to conserve space.
- H. Group piping whenever practical at common elevations.
- I. Support cast iron drainage piping at every joint.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

- K. Provide clearance in hangers and from structure and other equipment for installation of insulation.
- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- N. Install bell and spigot pipe with bell end upstream.
- O. Sleeve pipes passing through partitions, walls and floors. Refer to Section 22 05 29.
- P. Provide heavy-duty clamps, fittings and gaskets at no-hub connections to all roof and overflow drains then transition to bell and spigot piping system.
- Q. Insulate all horizontal storm drain piping with fiberglass insulation with service jacket. For exposed locations provide rigid insulation with rigid jacket. Insulate from roof drain body, past first elbow all the way to change to vertical direction, including y-fittings.

3.4 RODDING SEWERS

- A. All storm lines, both in the building and out, shall be rodded out after completion of the installation.
- B. This Work shall be done, as part of the contract, to make certain that all lines are clear, and any obstruction that may be discovered shall be removed immediately. Rodding shall be accomplished by utilizing a rotary cutter, which shall be full size of pipe being cleaned. Rodding operations shall be witnessed by Owner's field representative. Submit a certificate of completion to owner.

END OF SECTION 22 14 13

SECTION 22 20 23 - GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. SECTION 22 05 00 – COMMON WORK RESULT FOR PLUMBING
- C. SECTION 22 05 48 – EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING
- D. SECTION 22 05 29 – PLUMBING PIPE HANGERS AND SUPPORTS
- E. SECTION 22 05 48 – VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
- F. SECTION 22 05 48.13 – VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

1.3 SUMMARY

- A. Provide a complete natural gas piping system to all gas-burning appliances and all natural connectors.
- B. This section covers the complete first class natural gas system installation, within and to five (5) feet beyond building perimeter unless noted otherwise on Contract Drawings, including but not limited to piping, regulators, unions, valves, installation, testing and other normal parts that make the systems complete, operable, code compliant and acceptable to the authorities having jurisdiction.

1.4 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. 2015 Edition of the International Fuel Gas Code.
 - 2. Latest Edition of NFPA 54, National Fuel Gas Code.
 - 3. Minimum Safety Standards for Natural Gas, 49 Code of Federal Regulations (CFR) Part 192, as Required by Title 16 of the Texas Administration Code § 8.70.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.
 - d. Tape form pipe coating.
- B. Test Reports: Indicate results of piping system pressure test.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves, piping system, and system components.
- B. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.7 QUALITY ASSURANCE

- A. All materials, equipment and Work shall meet or exceed all applicable federal, state and local requirements and conform to codes and ordinances of authorities having jurisdiction.
- B. Valves: Manufacturer's name, size, standards compliance and pressure rating clearly marked on outside of valve body.
- C. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.
- E. Installer Qualifications: Company specializing in performing the Work of this Section with minimum three (3) years documented experience. Installation of natural gas systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. All installation shall be supervised by a licensed Master Plumber. All testing shall be performed by a licensed Journeyman or Master Plumber. Welders shall be certified in accordance with ASME Section 9.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.10 EXTRA MATERIALS

- A. Furnish two packing kits for each type and size valve.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products and materials listed herein are for references of approved materials.
- B. Unless noted otherwise, the contract documents (schedule sheet) will specify the products and materials that are to be used for this project.

2.2 NATURAL GAS PIPING, BELOW GRADE

- A. Steel Pipe: ASTM A53 Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M forged steel welding type or ANSI LC-4/CSA 6.32 press-connect type (MegaPressG by Viega).
 - 2. Joints: ASME B31.9, welded or ANSI LC-4/CSA 6.32, press-connect.
 - 3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
- B. Contractor Option: Provide Underground Gas Polyethylene (PE), SDR-11, ASTM D2513 pipe and fittings with heat fusion socket joints.
 - 1. Polyethylene pipe and fitting materials shall be compatible and by same manufacturer to ensure uniform melting and a proper bond. Fabricated fittings shall not be used.
 - 2. Provide connection between buried plastic gas service piping and metallic riser in accordance with the gas code. Provide metallic riser consisting of HDPE fused coating on steel pipe for connection to above ground building distribution piping. Underground horizontal metallic portion of riser shall be at least twenty four inches in length before connecting to the plastic service pipe. An approved transition fitting or adaptor meeting design pressure rating and plastic pipe manufacturers recommendations shall be used where the plastic joins the metallic riser.

2.3 NATURAL GAS PIPING, ABOVE GRADE (OUTDOOR)

- A. Piping 1½ inches and smaller shall be seamless Schedule 40 black steel, ASTM A106 or ASTM A53 Type "S", Grade A or B, with Class 150 black malleable iron threaded fittings conforming to ASME B16.3.
- B. Piping 2 inches and larger shall be Type "S" seamless or Type "E" electric resistance welded Schedule 40 black steel, ASTM A53, Grade A or B, with Schedule 40 wrought carbon steel fittings, ASTM A 234 and butt weld joints.
- C. Provide factory-applied, three-layer coating of epoxy, adhesive, and PE or field applied primer and epoxy paint coating on all pipe and fittings. Field applied coating is restricted to fittings and short sections of pipe necessarily stripped for threading or welding. Field coating shall be manufactured by Amercoat Type 240 or approved equal and applied in accordance with manufacturer's recommendations. Galvanizing shall not be considered adequate protection.

2.4 NATURAL GAS PIPING, ABOVE GRADE (INDOOR)

- A. Steel Pipe: ASTM A53 Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, [ANSI LC-4/CSA 6.32 press-connect \(MegaPress by Viega\)](#), or ASTM A234/A234M forged steel welding type.
 - 2. Joints: NFPA 54, threaded [or press-connected](#) through 2" max size or welded to ASME B31.9 above 2" size.
 - 3. EXCEPTIONS:
 - a. All exposed piping 1½ inches and smaller located within areas utilized as return air plenums shall have welded joints with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.
 - b. All exposed piping 1½ inches and smaller serving laboratories from main natural gas riser to each emergency shut-off valve shall have welded joints with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.

2.5 UNIONS AND COUPLINGS

- A. Ferrous pipe: 150 psi malleable iron threaded connections.
- B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.6 VALVES

- A. Manufacturers:
 - 1. Apollo.
 - 2. NIBCO.
 - 3. Milwaukee.
 - 4. Bray.
- B. Ball Valves:
 - 1. 1/4 inch to one (1) inch, MSS SP 110, 250 psi, two piece, threaded ends, bronze body, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port. Nibco T-585-70-UL.

2. 1-1/4 inch to 3 inch, MSS SP 110, 250 psi, two piece, threaded ends, bronze body, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port. Nibco T-580-70-UL.

2.7 STRAINERS

- A. Manufacturers:
 1. O.C. Keckley Company or approved equal.
- B. Two (2) inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. 2-1/2 inch to four (4) inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. Five (5) inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.8 NATURAL GAS PRESSURE REGULATORS

- A. Manufacturers:
 1. Fisher, or approved equal.
- B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 1. Temperatures: minus 20 degrees Fahrenheit to 150 degrees Fahrenheit.
 2. Body: Steel.
 3. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 4. Disk, diaphragm, and O-ring: Nitrile.
 5. Maximum inlet pressure: 150 psig
 6. Furnish sizes two (2) inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.9 NATURAL GAS PRESSURE RELIEF VALVES

- A. Manufacturers:
 1. Fisher 289H, or approved equal.
- B. Product Description: Spring loaded type relief valve.
 1. Body: Aluminum.
 2. Diaphragm: Nitrile.
 3. Orifice: Brass.
 4. Maximum operating temperature: 150 degrees Fahrenheit.
 5. Inlet Connections: Threaded.
 6. Outlet or Vent Connection: Same size as inlet connection.

2.10 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum six (6) inches wide by four (4) mil thick, manufactured for direct burial service.

2.11 PROTECTIVE COATING

- A. Underground steel service entry piping shall be furnished with factory applied plastic coating and field coating at joints conforming to AWWA Standard C-203. All valves, fittings, and joints in underground piping shall be field coated using a heat-applied coal tar enamel tape, using two coats of heavy mastic, using "Scotchwrap," "CT Tapecoat" or "X-Tru-Tape." Field coating shall extend over mill wrapping a minimum of 4 inches. Damaged coating shall be repaired as specified for valves, fittings, and joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Install plastic ribbon tape continuous over top of pipe buried six (6) inches below finish grade, above pipe line.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Establish minimum separation of gas pipe from other services, piping in accordance with code.
- C. Install continuous jacket or tape.
- D. Install gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure regulators. Gas service distribution piping to have initial minimum pressure of 5 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.
- E. Install Work in accordance with Gas Company standards.
- F. Pressure test natural gas piping in accordance with NFPA 54. Pressure test prior to backfill, minimum 50 psi for 24 hours.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide rigid appliance connections for each gas-burning appliance in accordance with code.
- C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- D. Provide an accessible, approved shut-off valve within three (3) feet of each gas appliance. Install such that appliance can be maintained and removed without removal of the shutoff valve.
- E. Install gas pressure regulator vent full size opening on regulator and terminate outdoors.
- F. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 5 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.
- G. Install service pipe and set gas meters in accordance with Gas Company regulations.
- H. Gas piping installed in plenums and chases shall be welded.
- I. In natatorium, including equipment rooms, all exposed plumbing piping shall be insulated and protected by a complete aluminum jacketing system. Refer to Section 23 07 16 for specification on jacketing. Provide color coded, printed pipe label 10' on center identifying pipe service type (gas, domestic water, storm water, etc.).
- J. Provide shut-off valves on both sides of all gas regulators for isolation of gas regulators.
- K. Provide a manual shut off valve on the appliance gas supply line in addition to the Kitchen Ansul unit automatic shut off.
- L. Provide a gas valve manifold to isolate kitchen gas appliances individually at one location.
- M. Provide separate gas valves on each fixture in labs.
- N. Provide a gas isolation valve on the lab controller unit.
- O. Install a test port of each side of all natural gas pressure regulators.
- P. Perform a pressure test of all replaced natural gas piping.
- Q. Gas piping on roof shall be supported at appropriate intervals to prevent sagging. Spacing shall be determined by the roof type and loading. No piping shall rest directly on the roof.
- R. All supports shall be manufactured for the purpose of supporting pipe. Wood blocks are not an acceptable means of pipe support.

3.5 FIELD QUALITY CONTROL

- A. Pressure test natural gas piping in accordance with NFPA 54. Pressure test prior to backfill, minimum 50 psi for 24 hours.
- B. Defective joints or piping shall be replaced as required and the system shall then be re-tested.

END OF SECTION 23 11 23

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide a complete installation for each equipment type listed in this section.
- B. Section Includes:
 - 1. COMMERCIAL NATURAL GAS DOMESTIC WATER HEATER
 - 2. VACUUM RELIEF VALVES
 - 3. IN-LINE CIRCULATORS
 - 4. T & P RELIEF VALVES
 - 5. DIAPHRAGM-TYPE EXPANSION TANKS
 - 6. BACKFLOW PREVENTERS
 - 7. WATER HAMMER ARRESTORS
 - 8. THERMOSTATIC MIXING VALVES
 - 9. HEAT TRACE
 - 10. SOLENOID VALVES

1.3 SUBMITTALS

- A. Product Data: Submit complete manufacturer's specification pages for each piece of equipment. Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Submit electrical characteristics and connection locations.
- B. Manufacturer's Installation Instructions: Submit mounting and support requirements.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept all equipment on site in original labeled cartons. Inspect for damage.
- B. Protect heat exchangers and tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.5 EXTRA MATERIALS

- A. Furnish two pump seals.

PART 2 - PRODUCTS

2.1 COMMERCIAL NATURAL GAS DOMESTIC WATER HEATER (Mim 95% EFF)

- A. Gas water heater(s) shall be equipped with a powered gas burner with electronic flame safeguard, intermittent electronic ignition, main and pilot automatic gas valves, redundant solenoid gas valve, gas pressure regulator, diaphragm switch for proof of boiler operation, and flame inspection port. Maximum gas supply pressure to heater(s) shall be 13" W.C., and ASME working pressure shall be 160 psi. Water heater(s) shall have the followings:
1. Modulating gas burner that automatically adjusts the input based on demand.
 2. Powered anodes that are non-sacrificial and maintenance free.
 3. Have seamless glass-lined steel tank construction, with glass lining applied to all water-side surfaces after the tank has been assembled and welded.
 4. Have a down-fired power burner designed for precise mixing of air and gas for optimum efficiency, requiring no special calibration on start-up
 5. Be approved for 0" clearance to combustibles.
- B. The control shall be an integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display, and shall have digital temperature readout and other components shall include manual-reset high-temperature limit control, upper and lower thermostats, combination temperature and pressure gauge, low-water cutoff, ASME-rated temperature and pressure relief valve, drain valve and draft regulator. Control compartment door shall be hinged for easy access.
1. All models are design certified by Underwriters Laboratories (UL), Inc., according to ANSI Z21.10.3 standards governing storage type water heaters.
 2. Meet the thermal efficiency and standby loss requirements of the U. S. Department of Energy and current edition ASHRAE/IES 90.1. Complies with SCAQMD Rule 1146.2 and other air quality management districts with similar requirements for low NOx emissions.
- C. The heater(s) shall meet or exceed current standard or ASHRAE/IESNA 90.1 for recovery efficiency and standby loss. The tank shall have a 3, 5, or 10 year warranty against failure as outlined in the written warranty. Professional start-up service shall be included.
- D. The tank shall be glass lined with alkaline borosilicate composition and fused to the steel by firing at 1600°F, and shall be insulated with fiberglass insulation. The heater will also be equipped with multiple anodes for cathodic protection. Heater(s) shall be equipped with 1-1/2" NPT water inlet and outlet openings, and two 3" handhole cleanouts. The heater(s) shall be constructed on accordance with ASME code, and the entire unit listed by Underwriters Laboratories.
- E. Water heater(s) shall capable for remote monitoring, leak detection and fault alert. Provide dry contacts for shut down command from CO monitor.

- F. Capacities:
1. GHW-X (X = as scheduled):
 - a. Located in hot water boiler room, gallon per hour recovery at 100 degree rise.
 - a. Water storage as scheduled.
 - b. Provide regulator for 5 lb. gas service pressure.
 - c. Provide single point power connection as scheduled.
 - d. AO Smith, Ruud, American water heater, Rheem or approved equal.
 2. 120K-250K BTU Input: For Standard Power Venting: Water heater(s) shall be suitable for power venting using a 4" diameter pipe for a total distance of (120 ft.) equivalent feet of vent piping. For Power Direct Venting: Water heater(s) shall be suitable for power direct venting using a 4" diameter pipe for a total distance of (120 ft.) equivalent feet of vent piping and (120 ft.) equivalent feet of intake air piping.

VACUUM RELIEF VALVES

- G. Construction shall be bronze body with silicone disc having a dry guide which is located out of the water. Unit shall open at less than 1/2" vacuum and be suitable for use within a system having a maximum water pressure of 200 psi and a maximum temperature of 250°F. Vacuum relief valves shall be in compliance with the appropriate requirements of ANSI Z21.22.
- H. Vacuum relief valves shall be manufactured by Watts Regulator, Wilkins or Conbraco.

2.2 IN-LINE CIRCULATORS

- A. Manufacturers:
1. Bell and Gossett
 2. Taco
 3. Aurora
 4. Armstrong
 5. Grundfos
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig, 175 psig maximum working pressure.
- C. Casing: Cast iron, with flanged pump connections.
- D. Impeller: Cast bronze, dynamically balanced and keyed on shaft.
- E. Bearings: Two, oil lubricated bronze sleeve, integral thrust collar.
- F. Seal: Carbon rotating against stationary ceramic seat, 212 degrees Fahrenheit maximum continuous operating temperature.
- G. Drive: Flexible coupling.
- H. Fitted with remote heat sensing aquastat and timer.

2.3 T & P RELIEF VALVES

- A. Manufacturers: Watts Industries, or approved equal.
- B. Temperature and Pressure Relief:
 - 1. ANSI Z21.22 certified, bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees Fahrenheit, capacity ASME Section IV certified and labeled.
- C. Vacuum Relief Valves:
 - 1. Watts N36 Lead Free Series.

2.4 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Manufacturers: Bell & Gosset PT Series, or approved equal.
- B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.
- D. Provide separate support to structure for expansion tank

2.5 BACKFLOW PREVENTERS

- A. Manufacturers: Watts Series LF909, or approved equal.
- B. Reduced Pressure Backflow Preventers:
 - 1. Comply with ASSE 1013.
 - 2. Bronze body, with bronze internal parts and stainless steel springs.
 - 3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.
- C. Double Check Valve Assemblies: Comply with ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
- D. Lead Free.

2.6 WATER PRESSURE REGULATING VALVES

- A. Low to Moderate Flow Systems (Less Than 70 GPM) and Individual Equipment
 - 1. Sizes 1/2" through 2"
 - 2. All bronze body
 - 3. 0.25% maximum weighted average lead content
 - 4. Integral stainless steel strainer screen
 - 5. Built-in bypass check valve

6. FDA approved elastomers
 7. Renewable seat
 8. Union end connection
 9. Rated for water temperature up to 180°F and minimum 300 psi inlet pressure. Provide model with inlet pressure rating, reduced pressure range and factory preset outlet pressure as scheduled on Contract Drawings.
 10. Manufactured by Wilkins Series 600XL or approved equal by Watts
- B. Large Demand Systems
1. Sizes 1-1/4" through 2 - ASTM B62 bronze body
 2. Sizes 2-1/2" and larger - ASTM A536 ductile iron body
 3. Pressure reducing pilot control
 4. Stainless steel disc guide, seat and bearing cover
 5. Stainless steel stem, nut and spring
 6. FDA approved Nylon reinforced Buna-N rubber diaphragm
 7. Provide model(s) with size, temperature range, inlet pressure rating, reduced pressure range, outlet pressure and options as scheduled on Contract Drawings.
 8. Cla-Val Company Series 90 or approved equal by Watts

2.7 WATER HAMMER ARRESTORS

- A. Manufacturers: Watts Series LF15M2 Series, or approved equal.
- B. ANSI A112.26.1; copper construction, piston type sized in accordance with PDI WH-201.
- C. Pre-charged suitable for operation in temperature range 33 to 180 degrees Fahrenheit and maximum 150 psi working pressure.
- D. Access Panel: Acorn Model 8292, or approved equal.
- E. Lead Free.

2.8 THERMOSTATIC MIXING VALVES:

- A. Manufacturers: Lawler, or approved equal.
- B. Certified to ASSE Standard 1017, ASSE 1070, and meets the anti-scald requirements of ASSE Standard 1016.
- C. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment.
- D. Capacity:
 1. TMV-1: Lawler 1070 Series, 2 gpm at 50 psi pressure drop. Lead Free.

- E. Accessories:
 - 1. Check valve on inlets.
 - 2. Volume control shut-off valve on outlet.
 - 3. Stem thermometer on outlet.
 - 4. Strainer stop checks on inlets.
- F. Cabinet: 16 gage stainless steel, for recessed mounting with keyed lock.
- G. Mechanical Rooms: Omit cabinet, surface mount.
- H. Mount TMV-1 in piping under lavatory.
- I. Lead Free.

2.9 HEAT TRACE

- A. Manufacturers:
 - 1. Thermon
 - 2. Emerson-Chromalox
 - 3. Pyrotenax
 - 4. Briscoe
 - 5. Raychem
- B. Provide a complete system of self-regulating heating cable on all domestic water piping in crawl spaces, un-conditioned attic spaces and outdoors and any other locations subject to freezing.
- C. Conform to ANSI/IEEE 515.1-1995.
- D. Heat trace shall operate at 120 volts, A.C., without the use of transformers.
- E. System shall have integral control system to provide automatic heating operation to maintain pipe temperature at 40° F. in outdoor temperatures to 0° F.
- F. Provide quantity of 120 volt branch circuits as required to serve heat trace load, maximum 1800 watts per circuit.

2.10 SOLENOID VALVES

- A. ASCO Series Next Generation
- B. Provide at each kitchen cooking hood and at each science lab prep room and demo table where for automatic gas supply shut-off.
- C. Coordinate electrical connections with Division 26.

2.11 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Coordinate required voltage, wire size and over current device size with electrical drawings. Contractor shall provide all electrical connections per manufacturer's installation instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.
- B. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and six (6) inches larger than water heater base on each side. Refer to Section 03 30 00.
- C. Connect natural gas piping in accordance with NFPA 54.
- D. Provide water heater pan beneath all water heaters with 3/4 inch drain to nearest floor sink.
- E. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.
- F. Install the following piping accessories.
 - 1. On supply:
 - a. Thermometer well and thermometer.
 - b. Strainer.
 - c. Pressure gage.
 - d. Shutoff valve.
 - e. Diaphragm-type expansion tank
 - 2. On return:
 - a. Thermometer well and thermometer.
 - b. Pressure gage.
 - c. Shutoff valve.
- G. Install the following piping accessories on natural gas piping connections.
 - 1. Strainer.
 - 2. Pressure gage.
 - 3. Shutoff valve.
 - 4. Pressure reducing valve.
- H. Install discharge piping from relief valves and drain valves to nearest floor drain.
- I. Install circulator and diaphragm expansion tank on water heater.
- J. Install water heater trim and accessories furnished loose for field mounting.
- K. Install electrical devices furnished loose for field mounting.
- L. Install control wiring between water heater control panel and field mounted control devices.

- M. On gas-fired equipment connect flue to water heater outlet, full size of outlet.
- N. Provide factory start-up and demonstration, including operating instructions for all gas-fired water heaters. Schedule training sessions with Architect and Owner's representative. Provide certification letter from manufacturer indicating water heater is installed in accordance with manufacturer's instructions.
- O. Circulating Pump Installation: Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
- P. Install diaphragm-type expansion tank on cold water supply line.

END OF SECTION 22 30 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide a complete system of plumbing fixtures and trim.
- B. All materials and equipment for the potable water system shall meet the latest mandates and requirements for lead free required by law that goes into effect January 2014.

1.3 SUBMITTALS

- A. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- B. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.5 EXTRA MATERIALS

- A. Furnish two sets of faucet washers flush valve service kits lavatory supply fittings shower heads toilet seats.

PART 2 - PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

- A. Fixture Manufacturers:
 - 1. American Standard Plumbing.
 - 2. Kohler Co.
 - 3. Zurn.
- B. Fixture Trim Manufacturers:
 - 1. Bemis
 - 2. Beneke
 - 3. Church
 - 4. Delaney

5. Sloan Valve Co.
 6. Zurn Industries.
- C. WC-1: ASME A112.19.2M; floor mounted, siphon jet vitreous china closet bowl, with elongated rim, 1-1/2 inch top back spud, china bolt caps. Provide as indicated on plumbing fixture schedule.
1. Floor mounted: Kohler Model Wellcomme Ultra K-96053
 2. Or provide as indicated on plumbing fixture schedule
- D. WC-2: Same as WC-1, except mounted at ADA/TAS height for appropriate age group.
1. Floor mounted: Kohler Model Highcliff K-96057-SSL-0
 2. Or provide as indicated on plumbing fixture schedule
- E. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with non-hold open handle, escutcheon, seat bumper, 2" offset flush connection, integral screwdriver stop and vacuum breaker; maximum 1.28 gallon. Sloan Model Royal or Zurn AV Series or Sloan 111-1.28 (standard), Sloan 115-1.28 DFB (ADA) or provide as indicated on plumbing fixture schedule.
- F. Seat: White/Black plastic, open front, extended back, self-sustaining hinge, stainless steel mounting hardware, brass bolts, with without cover. Manufacturer: Bemis, Beneke, Olsonite, and Church. Bemis 1655CT or provide as indicated on plumbing fixture schedule.

2.2 WALL HUNG URINALS

- A. Fixture Manufacturers:
1. American Standard Plumbing.
 2. Kohler Co.
- B. Fixture Trim Manufacturers:
1. Delaney
 2. Sloan.
 3. Zurn.
- C. All urinal flush valves shall meet the latest mandates and requirements for lead free required by law that goes into effect January 2014.
- D. U-1: ASME A112.19.2M; vitreous china, wall hung, elongated rim integral trap, removable stainless steel strainer, 3/4 inch top spud, provide chair carrier as required. Kohler Model Bardon K-4904-ET or provide as indicated on plumbing fixture schedule.
- E. U-2: Same as U-1, except mounted at ADA/TAS height for appropriate age group.
- F. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with non-hold open handle, escutcheon, integral screwdriver stop with vandal resistant stop

cap, vacuum breaker; maximum one (1) pint flush volume. Sloan Model Royal, or Zurn AV series. Sloan Flushometer 186-0.125 DBP or provide as indicated on plumbing fixture schedule.

- G. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with rectangular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs. Provide bottom bearing plate. Jay R. Smith figure 0637, or equal by Zurn and watts or provide as indicated on plumbing fixture schedule.

2.3 LAVATORIES

- A. Fixture Manufacturers:
1. American Standard Plumbing.
 2. Kohler Co
 3. Crane
 4. Eljer
- B. Fixture Trim Manufacturers:
1. Sloan
 2. T & S Brass.
 3. Chicago.
 4. Speakman.
- C. All lavatory faucets and trim shall meet the latest mandates and requirements for lead free required by law that goes into effect January 2014.
- D. L-1, Vitreous China Wall Hung Basin: ASME A112.19.2M; Kohler Model K-2005 vitreous china wall hung lavatory 21 x 15 inch minimum, with four (4) inch high back, 3 deck holes, rectangular basin with splash lip, front overflow, and soap depression. Provide floor mounted carrier for correct lavatory type. Provide as indicated on plumbing fixture schedule.
1. Supply Fitting: ASME A112.18.1 (Type A); chrome plated brass spout, metering valve cartridge, supply fitting with open grid strainer, water economy aerator with maximum 0.5 gpm flow, ADA compliant. Chicago Faucet Co. Series, or equivalent by T&S Brass, and American Standard. Chicago 802-VE2805-665ABCP or provide as indicated on plumbing fixture schedule.
- E. Accessories:
1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 2. Chrome plated 17 gage open grid P. O. plug.
 3. Removable key stops.
 4. Flexible supplies.
 5. Trap and waste insulated and offset to meet ADA compliance.

- 6. Tempering valve – Power LFe480 series, Acorn, or Leonard.
- F. Floor Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs. Jay R. Smith 710 Series, or equal by Zurn and watts.

2.4 SHOWERS (Regular) – (SH-1)

- A. Manufacturers:
 - 1. Chicago Faucet Co.
 - 2. Acorn Engineering Company.
 - 3. Speakman.
 - 4. Leonard Valve Co.
 - 5. Symmons
 - 6. Powers
- B. SH-1: ASME A112.18.1; concealed shower supply with pressure balanced or thermostatic mixing valves, integral service stops, chrome plated vandal-proof institutional head with integral wall bracket, built-in 1.5 gpm flow, and escutcheon. Acorn 418B-W or provide as indicated on plumbing fixture schedule.

2.5 SHOWERS (ADA) – (SH-2)

- A. Manufacturers:
 - 1. Acorn Engineering Company.
 - 2. Powers.
 - 3. Approved equal.
- B. SH-2 ADA: ASME A112.18.1 and ASSE 1016-2011; concealed shower supply with pressure balanced and thermostatic mixing valves, integral service stops, hand held shower (HHC25) with 69 inch metal clad hose and 24 inch glide mounted on right hand side (HSH), flow rate 1.5 GPM. ACORN 418ADAWH-W-PSO-LCH-LFS-LGB-SB or provide as indicated on plumbing fixture schedule.

2.6 SHOWERS (Regular) – (SH-3)

- A. Manufacturers:
 - 1. Chicago Faucet Co.
 - 2. Acorn Engineering Company.
 - 3. Speakman.
 - 4. Leonard Valve Co.
 - 5. Symmons
 - 6. Powers

- B. SH-3: ASME A112.18.1; concealed shower supply with metered valve, integral service stops, chrome plated vandal-proof institutional head with integral wall bracket, built-in 1.5 gpm flow, and escutcheon. Acorn 416B-W or provide as indicated on plumbing fixture schedule.

2.7 SHOWERS (ADA) – (SH-4)

- A. Manufacturers:
 - 1. Acorn Engineering Company.
 - 2. Powers.
 - 3. Approved equal.
- B. SH-4 ADA: ASME A112.18.1 and ASSE 1016-2011; concealed shower supply with pressure balanced and thermostatic mixing valves, integral service stops, hand held shower (HHC25) with 69 inch metal clad hose and 24 inch glide mounted on right hand side (HSSH), flow rate 1.5 GPM. ACORN 416BBF-W-LFS-LGB-LRD-SB or provide as indicated on plumbing fixture schedule.

2.8 ELECTRIC DRINKING FOUNTAIN

- A. Manufacturers:
 - 1. Elkay Mfg.
 - 2. Halsey Taylor
 - 3. Oasis Corp.
 - 4. Haws.
- B. Fountain: (EDF-1)
 - 1. ARI 1010; (ADA) Hydroboost bottle filling station, bi-level cooler, wall mount, non-filtered, non-refrigerated stainless. Mechanically activated, sanitary sensor activated, green counter, laminar flow, antimicrobial, real drain. Electronic bottle filler sensor with mechanical front and side bubbler pushbar. Halsey Taylor Model HTHB-HACDBLSS-NF provide as indicated on plumbing fixture schedule.
 - 2. Capacity: 7.6 gph of water with inlet at 80 degrees F and room temperature of 90 degrees Fahrenheit.
 - 3. Electrical: 115V / 60HZ. Maximum 1/5 hp compressor, cord and plug for connection to electric wiring system including grounding connector.
 - 4. Provide cane touch apron, Halsey Taylor Model 42522 for HAC Series or provide as indicated on plumbing fixture schedule.

2.9 EMERGENCY EYE AND FACE WASH (EW-1)

- A. Manufacturers:
 - 1. Encon Safety Products
 - 2. Haws.
 - 3. Bradley.
 - 4. Guardian Safety Equipment

- B. ANSI Z358.1; wall mounted, stainless steel bowl with elbow, 1-1/4 inch galvanized steel waste, instant action stay open valve actuated by push flag, four spray heads, dust cover assembly and wall mount bracket. Tailpiece and chrome plated brass P-trap supplied by others. Furnish universal emergency sign. Guardian Model GBF-1994BC w/ AP-275-600 or provide as indicated on plumbing fixture schedule.

2.10 EMERGENCY COMBINATION SHOWER WITH EYE AND FACE WASH (EW-#)

- A. Manufacturers:
 - 1. Encon Safety Products
 - 2. Haws Drinking Faucet Co.
 - 3. Bradley
 - 4. Guardian Safety Equipment
 - 5. Speakman
 - 6. Or approved equal
- B. Barrier Free, all stainless steel construction, corrosion resistant, combination eye/face wash and shower safety station with stainless steel shower head, stainless steel bowl, stainless steel flag handle and floor flange, 1 ¼" IPS Schedule 40 stainless steel pipe and fittings, 1" IPS and ½" IPS U.S. made stainless steel stay open ball valves, and polished stainless steel pull rod. Unit shall have (4) polypropylene 'GS Plus' spray heads with integral "flip-top" dust covers, filters, and 1.8-GPM flow control orifices mounted on a stainless steel head assembly. Unit shall include ANSI compliant sign.
- C. Performance: Unit complies with ADA requirements for accessibility by handicapped persons. Unit shall meet or exceed ANSI Z358.1 – 2004, and come with a full 2-year warranty.
- D. Fixture:
 - 1. (EW-2): Guardian Equipment GBF1994 or provide as indicated on plumbing fixture schedule.
 - 2. (EW-3): Guardian Equipment GBF 2150SSH-PCC for all Lab Classrooms.
 - 3. (EW-4): Guardian Equipment GBF1909SSH-GC (orange) For Central Plant and unfinished area.
- E. Alarm Option:
 - 1. AP275-200 alarm unit, with light and horn. (blue color light) Light and horn shall be installed in corridor outside of science lab (120 VAC, 0.5 AMP).
 - 2. Locate the blue light in the ceiling of the main corridor area directly outside room where emergency shower is installed. Provide one light per shower/valve configuration. Guardian AP280-235 (120v/1/60hz – 0.11 amp) for GBF 2150SSH-GC and Guardian AP280-230 (120v/1/60hz – 0.11 amp) for GBF 1909SSH-GC
- F. Hot water Option: TMV G3800LF Thermostatic mixing valve per ANSI Z358.1-2014.
- G. Supply and Waste Piping: 1-1/4 inch galvanized steel pipe pedestal with floor flange.

- H. Furnish universal emergency sign.

2.11 SERVICE SINKS (SS-1)

- A. Manufacturers:
1. Fixture Manufacturers:
 - a. Fiat Products
 - b. Florestone
 - c. Stern Williams
 2. Fixture Trim Manufacturers:
 - a. Chicago Faucet Co.
 - b. Fiat Products
 - c. Stern Williams
 - d. T & S Brass & Bronze Works Inc.
- B. SS-1: Single bowl 32 x 32 x 10 inch high. Receptor composed of pearl grey marble chips and white Portland cement ground smooth, grouted and sealed to resist stains, floor mounted, with 1-1/4 inch wide shoulders, vinyl bumper guard, stainless steel dome strainer. Stern Williams Model SBC-1900 or provide as indicated on plumbing fixture schedule.
- C. Accessories:
1. Three (3) feet of 5/8 inch diameter plain end reinforced synthetic hose with stainless steel wall bracket. Stern Williams Model T-35.
 2. Mop hanger. Stern Williams Model T-40.
 3. Or provide as indicated on plumbing fixture schedule
- D. SS-2: 12" corner type w/drop front, bowl 32 x 32 x 12 inch high. Receptor composed of pearl grey marble chips and white Portland cement ground smooth, grouted and sealed to resist stains, floor mounted, with 1-1/4 inch wide shoulders, vinyl bumper guard, stainless steel dome strainer, floor mounted. Stern Williams Model SBC-1725 or provide as indicated on plumbing fixture schedule.
- E. Accessories:
1. Three (3) feet of 5/8 inch diameter plain end reinforced synthetic hose with stainless steel wall bracket. Stern Williams Model T-35.
 2. Mop hanger. Stern Williams Model T-40.
 3. Or provide as indicated on plumbing fixture schedule

2.12 LAVATORY INSULATION KIT

- A. Manufacturers:
1. Truebro
 2. Plumberex
- B. Product Description: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

2.13 FLOOR DRAINS

- A. Manufacturers:
 - 1. Josam Mfg.,
 - 2. Jay R. Smith Mfg.,
 - 3. Wade Spec. Products
 - 4. Zurn Industries
 - 5. Mifab
 - 6. Watts
- B. Floor Drain (FD-1): ASME A112.21.1; Top round floor drain, lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer. Jay R. Smith Model 2010, 2015 or provide as indicated on plumbing fixture schedule.
- C. Floor Drain (FD-2): ASME A112.21.1; Top square floor drain, lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable square nickel-bronze strainer with removable perforated sediment bucket. Jay R. Smith 2010, 2015 or provide as indicated on plumbing fixture schedule.
- D. Floor Drain (FD-3): ASME A112.21.1; Cast iron flanged receptor with seepage holes, acid resistant coated interior and indirect waste drain, nickel bronze rim and secured grate. Aluminum dome bottom strainer or sediment bucket. Jay R. Smith Model 3020, 3021 or provide as indicated on plumbing fixture schedule.
- E. Floor Drain (FD-4): ASME A112.21.1; medium duty drains with 8-1/2" round top, duct cast iron body and flashing collar with cast iron bar. Jay R. Smith 2110, 2115. Provide as indicated on plumbing fixture schedule.
- F. Floor Drain (FD-5): ASME A112.21.1; Large capacity solid bottom suspended sediment bucket, fabricated steel body with galvanized coating inside and outside, cast iron grate, stainless steel ported bucket with mesh screen and lift bar. Jay R. Smith 2450, 2455. Provide as indicated on plumbing fixture schedule.
- G. Hubdrain (HD-1): Jay R. Smith 2270 Series or provide as indicated on plumbing fixture schedule.
- H. Hubdrain (HD-2): Stainless Steel. Jay R. Smith 9700 Series or provide as indicated on plumbing fixture schedule.

2.14 FLOOR SINKS

- A. Manufacturers:
 - 1. Josam Mfg.
 - 2. Jay R. Smith Mfg.
 - 3. Wade Spec. Products
 - 4. Zurn Industries

- 5. Mifab
- 6. Watts
- B. Floor Sink (FS-1): Cast iron body with integral seepage pan, acid resistant interior, nickel bronze rim and secured 1/2 grate. Aluminum dome bottom strainer and eight (8) inch square top. Jay R. Smith 3100 Series or provide as indicated on plumbing fixture schedule.
- C. FS-2, Jay R. Smith 3140-13, 12 inches, 3/4 grate or provide as indicated on plumbing fixture schedule.
- D. FS-3, Jay R. Smith 9700 Series, 12 inches, 3/4 grate or provide as indicated on plumbing fixture schedule.

2.15 TRAP SEAL PRIMERS

- A. Trap Seal Primers-Pressure Drop Type (TP-1)
 - 1. PPP model P2-500 pressure drop activated brass trap seal primer, with inlet opening of 1/2 inch (13) male N.P.T. and outlet opening of female 1/2 inch (13) N.P.T. Complete with four view holes and removable filter screen. Serves up to 6 floor drain traps and requires no adjustments and no air pre-charge.
 - 2. PPP model P1-500 trap seal primer distribution unit with four 3/8 inch (10) F.P.T brass nipple outlet connections to serve either 2, 3, or 4 floor drain traps and a 1/2 inch (13) M.P.T inlet connection. Unit complete with four 1/4 inch (6) diameter vent holes in the lid and three 1/8 inch (3) diameter Phillips Head screws to secure the lid to the body.
 - 3. Provide connection adapters as required for number of drains served.
 - 4. Install exposed in mechanical rooms at +48 " A.F.F. in readily accessible location.
- B. Trap Seal Primers-Flush Valve Type (TP-2)
 - 1. Vacuum breaker trap primer attached to water closet flush valve, similar to Sloan VBF-72-A.
- C. Trap Seal Primer: (TP-3), Jay R. Smith 2698 Series.
- D. Trap Seal Primer, Automatic, (TP-4), Jay R. Smith 2699 Series, Kitchen.

2.16 TRAP GUARDS

- A. Provide trap guards (TG-1) in all floor drains and floor sinks not in restrooms, kitchen, and mechanical rooms to be manufactured by Provent System
- B. Provide trap guards (TG-2) inline floor drain trap sealer to be manufactured by Rectorseal.

2.17 TRENCH DRAIN

- A. TD-1:
 - 1. Precast polyester concrete channel of interlocking design with built in slope of 0.6 percent. Radiused bottom, with stainless steel grate.
 - 2. Supply with concrete anchors, and required end caps and outlets. Six (6) inches wide and lengths as required, long. Not for use above grade.
 - 3. Smith/Aco Model 9931-ADA. Provide slotted Resin heavy duty ADA composite grate, JR Smith Model 9870-494-PADAB. Color to be selected by Architects

2.18 CLEANOUTS

- A. Cleanouts shall be provided where indicated on Drawings and elsewhere as required by code.
 - 1. Cleanouts in pipelines shall consist of cast iron ferrule and heavy duty cleanout plug with square head as scheduled on the Drawings. Where piping is concealed in floors or walls cleanouts shall be installed in or near surface of floor or walls and have countersunk plugs with covers
- B. Cleanouts shall be provided at the base of the stack on all sanitary, waste and drainage stacks. Base of stack cleanouts on piping located within walls or partitions shall be cast iron cleanout tee with countersunk plug and chromium-plated round access cover, J.R. Smith figure or approved equal.
- C. Manufacturers:
 - 1. Josam Mfg.
 - 2. Jay R. Smith Mfg.
 - 3. Wade Spec. Products
 - 4. Zurn Industries
 - 5. Mifab
 - 6. Watts
- D. Floor, Outdoors: Coated cast iron body with gasket seal ABS plug and round cast iron scoriated non-skid cover. Jay R. Smith, Model 4220-F-C-U.
- E. Floor, Indoors (CO): Coated cast iron body with gasket seal ABS plug, threaded top assembly with round nickel bronze scoriated cover in service areas. Jay R. Smith, Model 4025 – F-C-U.
- F. Wall Cleanout (WCO): Line type with lacquered cast iron body with bronze taper thread plug and round stainless steel access cover secured with vandal proof screw. Jay R. Smith Model 4420-U.
- G. Floor, Stainless Steel Indoors (CO): Coated cast iron body with gasket seal ABS plug, threaded top assembly with round stainless steel scoriated cover in service areas. Jay R. Smith Model 9760 Series.

2.19 ROOF DRAINS

- A. Manufacturers: Josam, J.R. Smith, Zurn or equal.
- B. Roof Drain (RD-1):
 - 1. Assembly: ASME A112.21.2M.
 - 2. Body: Lacquered cast iron with sump.
 - 3. Strainer: Removable aluminum dome with vandal proof screws.
 - 4. Accessories: Coordinate with roofing type, provide all required accessories:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Provide fixed extensions whenever possible in place of adjustable extensions when the distance needed is longer than what can be adjusted
- C. Roof Drain (RD-2):
 - 1. Assembly: ASME A112.21.2M.
 - 2. Body: Lacquered cast iron with sump.
 - 3. Strainer: Removable aluminum dome with vandal proof screws.
 - 4. Accessories: Coordinate with roofing type, provide all required accessories:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Use threaded connection for pipe sizes 6" or larger.
 - f. Provide fixed extensions whenever possible in place of adjustable extensions when the distance needed is longer than what can be adjusted
- D. Overflow Roof Drain (OD-1):
 - 1. Assembly: ASME A112.21.2M.
 - 2. Body: Lacquered cast iron with sump.
 - 3. Strainer: Removable aluminum dome with vandal proof screws.
 - 4. Waterdam extended to two (2) inches above flood elevation.
 - 5. Accessories: Coordinate with roofing type:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Provide fixed extensions whenever possible in place of adjustable extensions when the distance needed is longer than what can be adjusted
- E. All roof drains shall be provided with no-hub connection.

2.20 HOSE BIBS

- A. Manufacturers:
 - 1. Josam Mfg.
 - 2. Jay R. Smith Mfg.
 - 3. Woodford
 - 4. Zurn Industries
 - 5. Mifab
 - 6. Watts
- B. HB-1:
 - 1. Manufacturers: Woodford Model B24 or provide as indicated on plumbing fixture schedule.
 - 2. Interior: Polish brass, anti-siphon, vacuum breaker, enclosed in flush mounted wall box and adjustable brass nut with deep stem guard.
- C. HB-2:
 - 1. Manufacturers: Woodford Model B65, or provide as indicated on plumbing fixture schedule.
 - 2. Interior: Polish brass Bronze, automatic draining freezeless wall hydrant, single check hose connection anti-siphon vacuum breakers, hydrants drain as handle shut off , permanent type brass valve body with hemispherical seating surface.
- D. HB-3:
 - 1. Manufacturers: Woodford Model 24 or provide as indicated on plumbing fixture schedule.
 - 2. Interior: Polish brass, anti-siphon, vacuum breaker and adjustable brass nut with deep stem guard.

2.21 WALL HYDRANTS

- A. Manufacturers:
 - 1. Josam Mfg.
 - 2. Jay R. Smith Mfg.
 - 3. Woodford.
 - 4. Zurn Industries
 - 5. Mifab
 - 6. Watts
- B. WH-1:
 - 1. Woodford B65, Non-Freeze, or provide as indicated on plumbing fixture schedule.

2. ASSE 1019; Chrome, non-freeze, self-draining type with lockable recessed box hose thread spout, hand wheel locks shield and removable key, and integral vacuum breaker.
- C. WH-2:
 1. Woodford B22, Non-Freeze, or provide as indicated on plumbing fixture schedule.
 2. Wall Hydrant (WH-2): ASSE 1019; non-freeze, self-draining type with lockable recessed box hose thread spout, hand wheel locks shield and removable key, and integral vacuum breaker for hot and cold water.
- D. Yard Hydrant: WH-3
 1. Woodford HCB67, ASSE 1019, or provide as indicated on plumbing fixture schedule.
 2. Lockable box type, non-freeze hot and cold mixer, chrome finish with permanent type brass valve body with hemispherical seating surface, automatic draining and hose connection, backflow preventer and check valve.

2.22 RECESSED VALVE BOX

- A. Manufacturers: Guy Gray, or approved equal.
- B. RVB-1, Refrigerator/Ice Machine: Stainless steel preformed rough-in box with brass valves with wheel handle slip in finishing cover. IPS Model SSMIB8AB.
- C. RVB-2, Washing Machine: Galvanized steel preformed rough-in box with brass long shank valves with wheel handles, valves with single lever handle, socket for two (2) inch waste, slip in finishing cover. IPS Model SSWB-3.

2.23 DOWNSPOUT NOZZLES

- A. Manufacturers: Jay R. Smith 1770 Series or provide as indicated on plumbing fixture schedule.
- B. Product Description: Cast bronze body and wall flange round with offset bottom section.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01 31 13 - Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
- C. Verify electric power is available and of correct characteristics.
- D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key or screwdriver stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.
- F. For ADA accessible water closets, install flush valve with handle to wide side of stall.
- G. Emergency Shower: Provide a floor drain at each shower installation. Jay R. Smith Model 2005-A07NB-P or provide as indicated on plumbing fixture schedule.
- H. Provide power wiring, including control power transformers as required for all sensor type fixtures.
- I. Bolt carriers to the floor.
- J. All sinks shall have an offset rear centered drain.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Do not permit use of fixtures before final acceptance.

END OF SECTION 24 40 00

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all work for mechanical, plumbing and fire protection systems required in the project to be properly installed, tested and performing their intended function.

1.2 QUALITY ASSURANCE

- A. Perform all work in accordance with the latest edition of the applicable codes, specifications, local ordinances, industry standards, utility company regulations, nationally accepted codes.
- B. All materials and distribution, and utilization equipment shall be UL Listed.
- C. All equipment and materials shall be new, unused and of United States Domestic manufacture unless approved otherwise by engineer or owner.
- D. Eliminate any abnormal sources of noise that are considered by the Architect or Engineer not to be an inherent part of the systems as designed without additional cost to the Owner.

1.3 COORDINATION WITH OTHER TRADES

- A. Coordinate the work of this division with all other divisions to ensure that all components of the mechanical, plumbing and fire protection system will be installed at the proper time and fit the available space.
- B. Locate and size all openings in work of other trades required for the proper installation of the mechanical, plumbing and fire protection system components.
- C. Make all mechanical, plumbing and fire protection connections to all equipment furnished by this division and as required by any other division.
- D. Electrical wiring, control equipment and motor starters indicated on the electrical drawings, except items otherwise specifically noted, shall be furnished and installed by the electrical trades. Items of electrical control equipment specifically mentioned to be furnished by the mechanical trades, either in these specifications or on the mechanical drawings, shall be furnished, mounted and wired by this trade unless where otherwise specified in Division 26 or noted on the electrical drawings to be by the electrical trades. All wiring shall be in accordance with all requirements of the electrical Sections of these specifications.
- E. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment. All controllers furnished with mechanical equipment shall have overload protection in all phases. It shall be the responsibility of each subcontractor furnishing motors and devices to advise Electrical Contractor of exact function of systems to assure proper type of starter with correct number auxiliary contacts for proper operation of the system.

- F. The mechanical trades shall coordinate with the electrical contractor to ensure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.
- G. The design of the electrical systems is based on the mechanical equipment scheduled and shown on the drawings. Where changes or substitutions are made that involve additional electrical work (larger-size motors, larger number of motors, additional wiring of equipment, etc.), the mechanical trades shall pay the electrical trades for the cost of the additional work, except for changes by addendum.
- H. Motor control equipment which is furnished loose under Division 23 shall be delivered to the Electrical Contractor at the site for custody, erection in place, and wiring as specified.
- I. Smoke detection systems will be furnished and installed under Division 26 – electrical. Coordinate locations with Electrical Contractor.

1.4 DRAWINGS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Determine exact locations by review of equipment manufacturer's data, by job site measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. The size of the mechanical, plumbing and fire protection equipment indicated on the Drawings may be based on the dimensions of a particular manufacturer. While other listed manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment that the Contractor proposes to furnish will fit in the space. The drawings are not intended to show exact locations of pipes and ducts, or to indicate all offsets and fittings or supports, but rather to indicate approximate layout.
- B. The mechanical, plumbing and fire protection Drawings are necessarily diagrammatic in character and cannot show every connection in detail in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. When the mechanical, electrical, plumbing and fire protection Drawings do not give exact details as to the elevation of pipe, conduit and ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Exposed piping and ductwork is generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets and their location details. Work shall be concealed in all finished areas.

1.5 SUBMITTALS

- A. Provide shop drawings and complete product data as indicated in each specification section.
- B. Coordination Drawings: Using the mechanical ductwork shop drawings as a basis, provide a composite set of AutoCAD drawings in which the major mechanical, plumbing and fire protection equipment, ductwork and piping are superimposed on the architectural

reflected ceiling plan and structural framing plan. Include spot elevations of bottom of steel along with finished ceiling height. Prepare at 1/8 inch scale or larger, one drawing per building area. Provide 1/4 inch scale enlargements of locations where special attention to rough-in dimensions as required to ensure all systems will fit within the available space. Obtain approval of coordination drawings prior to duct fabrication and mechanical system hanger rough-ins.

- C. Shop Drawings will be reviewed and returned to the Contractor with one of the following categories:
1. **Reviewed:** No further submittal action is required. Submittal to be included in O & M Manual.
 2. **Revise and Resubmit:** Contractor to resubmit submittal as indicated in comments section of Engineer's Submittal Cover Letter.
 3. **Rejected:** Contractor to resubmit new submittal when alternate or substitution is not approved and be required to furnish product named in Specification and or Drawings.
 4. **Furnish as Corrected:** Contractor to submit letter verifying that required corrections noted on Engineer's Submittal Cover Letter have been received and complied with by manufacturer. If equipment on site is not in compliance with corrections noted, contractor shall be responsible for the cost of removing and replacing equipment.
- D. Materials and equipment which are purchased or installed without Submittal review and approval will be removed and replaced with specified equipment at Contractor's expense.
- E. Provide a specification review that consists of a copy of related specification section with notations indicating compliance or deviation with each element of specification.

1.6 CLOSEOUT SUBMITTALS

- A. Submit in accordance with Division 1 - General Requirements and each specification section.

1.7 INTERFERENCE DRAWINGS

- A. Where field conditions prohibit the installation of the mechanical, plumbing or fire protection system components within the available space as indicated on drawings, the Contractor shall prepare a sketch to the minimum 1/8 inch scale, clearly depicting the conflict along with an alternate installation arrangement that satisfies the design intent of the documents without incurring additional cost.
- B. Obtain written approval of proposed interference resolution prior to proceeding with alternate installation.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Equipment listed below shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.

- B. Contractor shall adequately protect equipment such as but not limited to: Chillers, Air Handling Units, Fan coil Units, Roof top Units, Air Terminal Units, Boilers, Pumps, Air Devices, exhaust fans, variable frequency drives, ductwork, duct insulation, piping insulation, hydronic piping, air duct accessories, unit heaters, etc. from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging; original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.
- D. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- E. Protect units from physical damage. Leave factory covers in place until startup of machine.

1.9 GENERAL ELECTRICAL REQUIREMENTS

- A. Provide electric motors, control panels, certain control and safety devices and control wiring when specified or required for proper operation of electrical systems associated with mechanical equipment specified in Division 23.
- B. Electrical materials and work provided shall be in accordance with Division 26.
- C. Notify Architect/Engineer in writing 14 days before bids are due if it is necessary to increase horsepower of any motors or change any electrical requirements listed or shown. After this period, costs incurred because of changes shall be assumed by the responsible Contractor.

1.10 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

- A. Mechanical equipment with factory assembled and/or attached electric equipment shall be Underwriters' Laboratories (UL) listed as an assembly when such listing is available from UL, and shall meet the latest edition of the National Electrical Code.
- B. Unless otherwise specified, the electrical supply being furnished is a 460 volt, 3 phase, 3 wire, 60 hertz source. No neutral connection is available from the 460 volt source. The manufacturer shall include any transformers for equipment requiring other voltages (277volt, 220 volt, 120 volt, 24 volt, etc.).
- C. Electric Motors:
 - 1. For each piece of equipment requiring electric drive, provide a motor having starting and running characteristics consistent with torque and speed requirements of the driven machine.

2. Manufacturers furnishing motors shall verify motor horsepower with the characteristic power curves of driven equipment on shop drawings.
3. Each motor shall be furnished in accordance with Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
4. Contractor shall verify electrical characteristics of each motor with electrical drawings.
5. Motors which are shipped loose from equipment shall be set by supplying subcontractor.
6. Alignment of motors factory coupled to equipment and motors field coupled to equipment shall be rechecked by millwright after all connections (belt drives, gear drives, impellers, piping, etc.) have been completed and again after 48 hours of operation in designed service.
7. Where possible, motors shall be factory mounted.

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 OWNER INSTRUCTION - GENERAL

- A. Installing Contractor shall coordinate and provide on-site Owner training for all new equipment by factory trained specialists for all Mechanical and Plumbing equipment in two (2) separate training meetings. One (1) training session shall be prior to Owner's acceptance and occupancy, and the other training session shall occur (30) thirty days later. Sign-in sheets are required for both meetings and shall be included in close out submittals.
- B. Use Operation and Maintenance manuals and actual equipment installed as basis for instruction.
- C. At conclusion of on-site training program have Owner personnel sign written certification they have completed training and understand equipment operation. Include copy of training certificates in final Operation and Maintenance manual submission.
- D. Refer to individual equipment specifications for additional training requirements.

END OF SECTION 23 05 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

GENERAL CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes single and three phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
- B. General: Provide motors for all equipment. Select for starting torque and starting current suitable for equipment loads and starting equipment. Horsepower rating shown on drawings are required, but motor must not be loaded more than 1.0 x nameplate horsepower. Provide larger motor if required to stay within this limitation, and include all costs for any required increases in electrical system.
- C. Electrical Characteristics: Provide nameplate ratings same as circuit voltage indicated on electrical drawings. Coordinate to give proper operation with starting equipment scheduled. See Division 26.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 – Motors and Generators.
- C. All motors furnished shall be designed, manufactured, and tested in accordance with the latest applicable standards of NEMA, ANSI, IEEE, and ASTM. As a minimum requirement, all motors shall conform to the latest applicable sections of NEMA Standard No. MG-1. Motors must meet or exceed the rebate levels for premium efficiency Motors established by the Consortium for Energy Efficiency (CEE).

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- B. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

- C. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTORS

A. Manufacturers:

1. Baldor
2. Marathon
3. General Electric
4. Weg
5. A.O. Smith

B. Motors 3/4 hp and Larger: Three-phase motor as specified below.

C. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

D. All motors controlled by a Variable Frequency Drive shall be NEMA MG-1 Section 31 Inverter-Fed Rated.

E. Three-phase Motors: NEMA MG-1, Design B, class H premium, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.

1. Service Factor: 1.15
2. Enclosure: Concealed Indoor: ODP, Exposed Indoor: Guarded ODP, Outdoor: Type II TEFC, Outdoor Weather Protected: Type I TEO.
3. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Insulation System: NEMA Class F.
5. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
6. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum ABMA 9, L-10 life of 40,000 hours. Calculate bearing load with NEMA standard shaft extension. Stamp bearing sized on nameplate.
7. Sound Power Levels: Conform to NEMA MG 1.
8. Factory finish starters shall be provided with integral phase failure protection to shut down motor upon loss of an electrical phase and automatically reset upon return of 3 phase power.

- F. Single Phase Motors:
 - 1. Permanent split-capacitor type where available, otherwise use split-phase start / capacitor run or capacitor start / capacitor run motor.
 - 2. Service Factor: 1.35.
- G. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

- A. General: All motor starters and magnetic contactors are specified in Division 26, except as follows:
 - 1. Starters and motors specified as part of a packaged piece of equipment.
 - 2. Centrifugal chillers which are provided with remote mounted starters under the chiller specification.
 - 3. Variable speed controllers for variable volume air handling units and cooling towers.
- B. Provide a tabulation of motors with all pertinent information required for properly rated motor controllers to be provided under Division 26.
- C. Provide a tabulation of matched motors and starters provided under Division 23.
- D. Variable speed motors controlled by variable frequency drives in general shall be of standard design called out in this specification. The manufacturer shall be notified on the requisition that the motor will be used in conjunction with a variable frequency drive and its type of frequency generation. It shall be the responsibility of the motor manufacturer to ensure that this motor will be capable of operating under the torque requirements and speed range within temperature specifications. The normal speed range shall be 4 to 1 ratio. The motor / drive system shall be capable of maintaining full torque throughout. The motors specified for variable speed application shall be capable of operating at 90 hertz maximum frequency as a minimum requirement but at reduced torque's above 60 HZ.

E. Efficiency: Minimum full load efficiency shall be as follows:

| Open Drip-Proof (ODP) | | | | Totally Enclosed Fan Cooled (TEFC) | | | |
|-----------------------|--------------------|--------------------|--------------------|------------------------------------|--------------------|--------------------|--------------------|
| | 1200 RPM | 1800 RPM | 3600 RPM | | 1200 RPM | 1800 RPM | 3600 RPM |
| HP | Minimum Efficiency | Minimum Efficiency | Minimum Efficiency | HP | Minimum Efficiency | Minimum Efficiency | Minimum Efficiency |
| 1 | 82.5 | 85.5 | 77.0 | 1 | 82.5 | 85.5 | 77.0 |
| 1.5 | 86.5 | 86.5 | 84.0 | 1.5 | 87.5 | 86.5 | 84.0 |
| 2 | 87.5 | 86.5 | 85.5 | 2 | 88.5 | 86.5 | 85.5 |
| 3 | 88.5 | 89.5 | 85.5 | 3 | 89.5 | 89.5 | 86.5 |
| 5 | 89.5 | 89.5 | 86.5 | 5 | 89.5 | 89.5 | 88.5 |
| 7.5 | 90.2 | 91.0 | 88.5 | 7.5 | 91.0 | 91.7 | 89.5 |
| 10 | 91.7 | 91.7 | 89.5 | 10 | 91.0 | 91.7 | 90.2 |
| 15 | 91.7 | 93.0 | 90.2 | 15 | 91.7 | 92.4 | 91.0 |
| 20 | 92.4 | 93.0 | 91.0 | 20 | 91.7 | 93.0 | 91.0 |
| 25 | 93.0 | 93.6 | 91.7 | 25 | 93.0 | 93.6 | 91.7 |
| 30 | 93.6 | 94.1 | 91.7 | 30 | 93.0 | 93.6 | 91.7 |
| 40 | 94.1 | 94.1 | 92.4 | 40 | 94.1 | 94.1 | 92.4 |
| 50 | 94.1 | 94.5 | 93.0 | 50 | 94.1 | 94.5 | 93.0 |
| 60 | 94.5 | 95.0 | 93.6 | 60 | 94.5 | 95.0 | 93.6 |
| 75 | 94.5 | 95.0 | 93.6 | 75 | 94.5 | 95.4 | 93.6 |
| 100 | 95.0 | 95.4 | 93.6 | 100 | 95.0 | 95.4 | 94.1 |
| 125 | 95.0 | 95.4 | 94.1 | 125 | 95.0 | 95.4 | 95.0 |
| 150 | 95.4 | 95.8 | 94.1 | 150 | 95.8 | 95.8 | 95.0 |
| 200 | 95.4 | 95.8 | 95.0 | 200 | 95.8 | 96.2 | 95.4 |

PART 3 - EXECUTION

3.1 REQUIREMENTS

- A. All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.
- B. All items required for a complete and proper installation are not necessarily indicated in the plans or in the specifications. Contractor's price shall include all items required as per manufacturer's requirements.

3.2 INSTALLATION

- A. General: Install in a professional manner. Any part of parts not meeting this requirement shall be replaced or rebuilt without extra expense.
- B. Install rotating equipment in static and dynamic balance.

- C. Provide foundations, supports, and isolators properly adjusted to allow minimum vibration transmission within the building. Refer to Section 23 05 48.
- D. Correct objectionable noise or vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

END OF SECTION 23 05 13

SECTION 23 05 14 - VARIABLE FREQUENCY DRIVES

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. The drive shall be designed specifically for variable torque applications. It is required that the drive manufacturer has an existing independent service organization.
- B. The drive and all necessary controls as herein specified shall be supplied by the drive Manufacturer. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten (10) years.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - 2. Underwriters laboratories
 - a. UL508C
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a. ICS 7.0, AC Adjustable Speed Drives
 - 4. IEC 16800 Parts 1 and 2
- B. Testing:
 - 1. All printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a computerized systems test (cold), burn-in, and computerized systems test (hot). The burn-in shall be at 104 degrees Fahrenheit at full rated load, on a motor. Drive input power shall be continuously cycled for maximum stress and thermal variation.
 - 2. All testing and manufacturing procedures shall be ISO 9001 certified.
- C. Failure Analysis:
 - 1. VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component. The failure analysis lab shall allow the manufacturer to perform complete electrical testing, x-ray of components, and decap or delaminate of components and analyze failures within the component.

- D. Qualifications:
 - a. VFD's and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable.

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Submit VFD's only after coordination with approved Air Handling Units, Pumps, and Cooling Tower Submittals (If applicable).
- C. All Variable Frequency Drives serving various equipment such as but not limited to: Air handling Units, Pumps and Cooling towers shall be supplied by the same manufacturer.
- D. Submittals shall include, as a minimum, the following information:
 - 1. Outline Dimensions
 - 2. Weight
 - 3. Compliance to IEEE 519 - harmonic analysis for particular job site including total harmonic voltage distortion and total harmonic current distortion.
 - a. The VFD manufacture shall provide calculations, specific to the installation, showing total harmonic voltage distortion is less than five (5) percent. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519 (latest version), guide for Harmonic Control and Reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior VFD installation.
 - b. If the voltage THD exceeds five (5) percent the VFD manufacturer is to recommend the additional equipment required to reduce the voltage THD to an acceptable level.

1.4 WARRANTY

- A. Warranty shall be (2) two years and shall begin from date of Certificate of Substantial Completion. The warranty shall include all parts, labor, travel time and expenses to provide on-site warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's original, unopened containers with identification labels intact.
- B. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.

- C. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.6 MANUFACTURERS

A. Acceptable Manufacturers:

- 1. ABB
- 2. Danfoss
- 3. Yaskawa

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES

- A. The adjustable frequency drives (VFD's) shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure (NEMA 4X if outdoors or unconditioned space), completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), Integral Line Reactor(s), Capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
 - 1. Input 480 VAC +/- 10 percent, 3 phase, 48-63 Hz. The overvoltage trip level shall be 30 percent over the nominal, and the under voltage trip level shall be 35 percent over the nominal voltage as a minimum.
 - 2. Output Frequency 0 to 250 Hz. Operation above 60 Hz shall require programming changes to prevent inadvertent high-speed operation.
 - 3. Environmental operating conditions: 0 to 104 Degree Fahrenheit, 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing.
 - 4. Conditioned indoors enclosure shall be rated NEMA 1 and shall be UL listed as a plenum rated drive. Drives without this rating are not acceptable.
 - 5. VFD's located in un-conditioned spaces or outdoors shall have rated NEMA 4X enclosure and shall be UL listed as a plenum rated drive. Drives without this rating are not acceptable.
- B. All VFD's shall have the following features:
 - 1. All VFD's shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus. The keypad shall be removable, capable of remote mounting, and shall have its own non-volatile memory. The keypad shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD's.

2. The keypad shall include Hand-Off-Auto membrane selections. When in "Hand", the VFD will be started and the speed will be controlled from the up/down arrows. When in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact closure and the VFD speed will be controlled via an external speed reference. The drive shall incorporate "bump less transfer" of speed reference when switching between "Auto" and "Hand" modes and vice-versa.
3. The VFD's shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to ACS400-US-reprogram all parameters and customer interfaces for a particular application to reduce programming time.
4. The VFD shall have the ability to automatically restart after an over current, overvoltage, under voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
5. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall also be capable of DC injection braking at start to stop a reverse spinning motor prior to ramp.
6. The VFD shall be equipped with an automatic extended control power loss ride-through circuit, which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Typical control power loss ride-through for a fan load shall be 2 seconds minimum.
7. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
8. The customer terminal strip shall be isolated from the line and ground.
9. The drive shall employ current limit circuits to provide trip free operation:
 - a. The Slow Current Regulation limit circuit shall be adjustable to 150 percent (minimum) of the VFD's normal duty current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
 - b. The Current Switch-off limit shall be fixed at 350 percent (minimum, instantaneous) of the VFD's normal duty current rating.
10. The overload rating of the drive shall be 110 percent of its normal duty current rating for one (1) minute in every ten (10) minutes. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
11. The VFD shall have an integral Line Reactor(s) to reduce the harmonics to the power line and to increase the fundamental power factor. The minimum impedance shall be three (3) percent.

12. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false under load condition.
13. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.
14. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
15. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector
 - c. Bypass mode selector
 - d. Bypass fault reset
16. The following indicating lights (LED type) shall be provided:
 - a. Power-on
 - b. External fault
 - c. Drive mode selected
 - d. Bypass mode selected
 - e. Drive running
 - f. Bypass running
 - g. Drive fault
 - h. Bypass fault
 - i. Automatic transfer to bypass selected
17. Customer Interlock Terminal Strip: Provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes.
18. The following relay (form C) outputs from the bypass shall be provided.
 - a. Drive run
 - b. Bypass run
 - c. Drive fault Bypass fault (motor overload or under load (broken belt)

19. Automatic or manual bypass (field selectable)
 20. Manual or automatic bypass fault (field selectable)
 21. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure.
 22. Door interlocked pad lockable circuit breaker which will disconnect all input power from the drive and all internally mounted options.
 23. Fast acting semi-conductor fuses exclusive to the VFD - fast acting semi-conductor fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the Bypass will not be accepted.
 24. Class 10 or 20 (selectable) electronic motor overload protection shall be included in the microprocessor bypass to protect the motor in bypass mode.
- C. All VFD's to have the following adjustments:
1. Two (2) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
 2. PID Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The auxiliary power supply shall have overload and over current protection. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.
 3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference or for reference and actual (feedback) signals for PID controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 ma and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz. Process variables shall be modifiable by math functions such as multiplication and division between the two signals (fan tracking), high/low select, as well as inverted follower.
 4. Five (5) programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (reclosure of interlock) drive is to resume normal operation.
 5. One (1) programmable analog output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
 6. Two (2) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs

shall be true form C type contacts; open collector outputs are not acceptable. Relays shall be capable of programmable on and off delay times.

7. Seven (7) programmable preset speeds.
 8. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
 9. The VFD shall Ramp or Coast to a stop, as selected by the user.
- D. The following operating information displays shall be standard on the VFD digital display. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of two operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
 2. Motor Speed (RPM, percent, or Engineering units)
 3. Motor Current
 4. Calculated Motor Torque
 5. Calculated Motor Power (kW)
 6. DC Bus Voltage
 7. Output Voltage
 8. Heat sink Temperature (0°F)
 9. Analog Input Values
 10. Analog Output Value
 11. Keypad Reference Values
 12. Elapsed Time Meter (resettable)
 13. kWh meter (resettable)
 14. mWh meter
 15. Digital input status
 16. Digital output status
- E. The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alphanumeric codes are not acceptable).
1. Over current trip 350 percent instantaneous (170 percent RMS) of the VFD's variable torque.
 2. Current rating.

3. Overvoltage trip 130 percent of the VFD's rated voltage.
 4. Under voltage trip 65 percent of the VFD's rated voltage.
 5. Over temperature +90 degrees Celsius.
 6. Ground Fault either running or at start.
 7. Adaptable Electronic Motor Overload (1 2 t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits, which are not speed dependant, are unacceptable. The electronic motor overload protection shall be UL approved for this function.
- F. Speed Command Input shall be via:
1. Keypad.
 2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal.
 3. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.
 4. Serial Communications
- G. Serial Communications
1. The VFD shall have an RS-485 port as standard. The standard protocol shall be BACnet. Optional protocols that must be available are: Johnson Controls N2 bus, Siemens Building Technologies FLN, LonWorks, Profibus and DeviceNet.
 2. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), percent torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information. Additionally, remote (LAN) VFD fault reset shall be possible. A minimum of 15 field parameters shall be capable of being monitored.
 3. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. The serial communications interface shall allow for DO (relay) control and AO (analog) control. In addition, all drive digital and analog inputs shall be capable of being monitored by the DDC system.

PART 4 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

- B. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 START-UP

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with drive products offered shall be locally available at both the specifying and installation locations.

END OF SECTION 23 05 14

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment roof curbs and support rails.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel and angle.
9. Equipment bases and supports.
10. Portable roof pipe supports.
11. Portable duct supports.
12. Modular four bar safety rail system.

- B. Related Sections:

1. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
2. Division 7 - Thermal and Moisture Protection.

1.3 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Pipe stands.
 4. Equipment supports.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather, construction traffic, dirt, water, chemical, and mechanical damage.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not apply Firestopping materials when temperature of substrate material and ambient air is below 60 degrees Fahrenheit.

B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of Firestopping materials.

C. Provide ventilation in areas to receive solvent cured materials.

1.8 WARRANTY

A. Furnish one (1) year manufacturer warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Carpenter & Paterson Inc.
2. Flex-Weld, Inc.
3. Globe Pipe Hanger Products Inc.
4. Michigan Hanger Co.
5. B-Line Systems
6. Carpenter & Patterson Inc.
7. Anvil International
8. Piping Technology & Products
9. Grinnell

B. Hydronic Piping:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes two (2) inches and larger: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 inches to 4 inches: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes six (6) inches and larger: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Galvanized Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes six (6) inches and larger: Galvanized Steel channels with welded spacers and hanger rods, cast iron rollers.
7. Wall Support for Pipe Sizes three (3) inches and smaller: Cast iron hooks.
8. Wall Support for Pipe Sizes four (4) inches and larger: Welded galvanized steel bracket and wrought steel clamp.
9. Wall Support for Hot Pipe Sizes six (6) inches and larger: Welded galvanized steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
10. Vertical Support: galvanized Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Hot Pipe Sizes four (4) Inches and smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes six (6) inches and larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
14. Copper Pipe Support: Copper-plated, carbon steel ring.
15. Hydronic Piping shall not have support brackets welded to hydronic piping.

C. Roof Mounted Hydronic Piping:

1. Refer to Division 7 –for hanger requirements and approved manufacturers.

2.2 HANGER RODS

- A. Hanger Rods: Hot dipped galvanized, mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. In accordance with Division 7 - Thermal and Moisture Protection.

2.5 EQUIPMENT ROOF CURBS AND SUPPORT RAILS

- A. Equipment roof curbs and support rails must be coordinated with roof type specified under Division 7.
- B. Roof mounted exhaust fans, intake hoods, relief hoods and supply fans shall be set on equipment manufacturers 12" high fabricated welded 18 gauge galvanized steel shell and base, mitered three (3) inch cant if required by roofing type, variable step to match roof insulation, 1-1/2 inch thick curb insulation, factory installed treated wood nailer. Curb shall set level on roof without the need for blocking.
- C. Roof mounted unitary air conditioning units shall be set on a structural type curb or equipment support rail. Curb or support rail shall be compatible with required vibration isolation specified under Section 23 05 48. Curb or support rail shall be 12" high welded 18 gauge galvanized steel shell and base, mitered three (3) inch cant if required by roofing type, variable step to match roof insulation, 1-1/2 inch thick insulation, 3 lb density, factory installed wood nailer and stainless steel cap. Curb shall set level on roof without the need for blocking. Field bolted curbs are not acceptable.
 - 1. Approved Manufacturers:
 - a. The Pate Co.
 - b. Custom Curb, Inc.
 - c. Roof Products, Inc.
- D. Refer to Division 7 - Thermal and Moisture Protection for additional requirements.

2.6 SLEEVES

- A. Sleeves for Pipes through fire rated or non-fire rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes through Rated or Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Sealant: Refer to Section 07 92 00 - Building Sealants.

2.7 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.8 FORMED STEEL CHANNEL AND ANGLE

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Midland Ross Corporation, Electrical Products Division
 - 4. Unistrut Corp.
- B. Product Description: Galvanized 14 gage thick steel angle and galvanized 12 gage thick steel channel with holes 1-1/2 inches on center. Metal framing system for equipment support.
- C. All channel members and angles shall be hot-dipped galvanized and fabricated from structural grade steel and conform to applicable ASTM specifications.
- D. Structural members to be loaded within manufacturers design limitations and published data.

2.9 MODULAR FOUR BAR SAFETY RAIL SYSTEM

- A. Manufacturers:
 - 1. Advanced Support Products (ASP).
 - 2. Or (10) ten day prior approved equal.
- B. Materials:
 - 1. Support Base: 17" circular base, injected molded polypropylene, with 227 sq. in. of surface on bottom, designed for weight displacement.
 - 2. Base Dimensions: 3"H x 17" in diameter, designed for weight displacement, with molded insert for square tubing and two threaded rod couplings molded in.
 - 3. Height: Adjustable.
 - 4. Frame: 2"x2" angle iron ASTM 572, grade 50 and 1" x 3/16" bar grating, 19-w-4 carbon steel, ends capped with 1" x 3/16" steel flat bar, welded, hot- dipped galvanized after fabrication.

5. Safety rails: 4 bar safety rail, 1-1/2" schedule 40 pipe, welded; safety rails are connected together using post and pin as a hinged design; all steel ASTM 572, grade 50, hot-dipped after fabrication.
6. Hardware: 1/2" x 1-1/2" bolts and 1/2" nuts; hot-dipped galvanized after fabrication.
- C. Roof protection pads: Provide roof protection pads sheets between the roof and support system. Roof protection pads shall not be adhered to either the roof or the support system.
 1. Material: Porous rubber.
 2. Weight: 2 lbs.
 3. Dimensions: 18" square X 1/2" thick.
- D. Refer to plans for minimum safety rail linear length requirement.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive Firestopping/Firesafing.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of Firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 STRUCTURAL STEEL

- A. All structural steel used to fabricate supports shall conform to ASTM A36.

3.4 CUTTING AND PATCHING

- A. In accordance with Division 7 - Thermal and Moisture Protection

3.5 FIRESTOPPING

- A. In accordance with Division 7 - Thermal and Moisture Protection.

3.6 FIRESTOPPING ACCESSORIES

- A. In accordance with Division 7 - Thermal and Moisture Protection.

3.7 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe four (4) inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.8 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every other floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports.
- L. Provide clearance in hangers and from structure and other equipment for installation of pipe insulation. Refer to Section 23 07 19 - HVAC Piping Insulation.

3.9 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Provide curbs for mechanical roof installations 12 inches minimum above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- C. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.
- D. Refer to Division 7 - Thermal and Moisture Protection for additional requirements.

3.10 INSTALLATION - SLEEVES

- A. Provide sleeves at all piping and ductwork penetrations of interior walls and slabs. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors two (2) inches above finished floor level. Caulk sleeves.
- E. Extend sleeves through walls two (2) inches each side.
- F. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with Firestopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install stainless steel escutcheons at finished surfaces.

3.11 INSTALLATION - FIRESTOPPING

- A. Install material at all fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items.
- B. Apply primer where recommended by manufacturer for type of Firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply Firestopping material in sufficient thickness to achieve required fire and smoke rating.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Fire Rated Surface:
 - 1. Seal opening at floor, wall, and partition as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
- F. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall and partition floor as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.

- b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
2. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
4. Interior partitions: Seal pipe penetrations. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.12 INSTALLATION - ACCESS DOORS

- A. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts and other apparatus where concealed. Access doors shall have concealed hinges and screw driver cam locks. Minimum size to be 12 inches x 12 inches in walls only for hand access and 24 inches x 24 inches minimum for all ceilings for maintenance access.
- B. All access doors located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.
- C. Access Doors:
 1. Plastic Surfaces: Milcor Style K.
 2. Ceramic Tile Surface: Milcor Style M.
 3. Drywall Surfaces: Milcor Style DW.
 4. Install panels only in locations approved by the Architect and with trim styles and color coordinated with surface to be installed in.

3.13 FIELD QUALITY CONTROL

- A. Inspect installed Firestopping for compliance with specifications and submitted schedule.

3.14 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.15 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

3.16 PIPE HANGERS

- A. Minimum hanger rod size shall be ½".
- B. Maximum hanger rod spacing shall not exceed 10'-0" on center for pipe sizes 2" and above. Do not exceed 7'-0" hanger spacing for pipes sizes less than 2" diameter.
- C. For trapeze supports provide a minimum of (2) two ½" hanger rods at each end of trapeze for a total of (4) four.

- D. Beam clamps are not acceptable.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Vibration isolation for building mechanical systems.
- B. Related Sections:
 - 1. Section - 23 05 16 - Expansion Fittings and Loops For HVAC Piping
 - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- C. Mason Industries model numbers are listed for identification only.
- D. Manufacturers:
 - 1. Mason Industries
 - 2. Kinetics Noise Control
 - 3. Amber / Booth
 - 4. VMC
 - 5. Vibration Eliminator

1.2 PERFORMANCE REQUIREMENTS

- A. It is the intent of this specification to provide vibration isolation supports for all equipment, piping and ductwork as may be required to prevent transmission of vibration to the building structure. It will be the Contractor's responsibility to select and install vibration isolators which will enable the noise criteria standards to be met, to the extent that the noise can be controlled by the vibration isolators.
- B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier.
- C. Unless otherwise noted or scheduled, spring type vibration isolators shall be used for all equipment driven by motors of 0.5 HP and larger. Deflections as tabulated are minimums and it shall be the responsibility of the isolation manufacturer to determine the amount of spring deflection required for each isolator to achieve optimum performance in order to prevent the transmission of objectionable vibrations and meet the noise criteria referenced herein.
- D. Unless otherwise noted, equipment driven by motors 0.25 HP and smaller shall be isolated by means of Type ND elastomeric mounts or Type HD elastomeric hangers properly sized for 0.35 inch deflection.
- E. All elastomeric isolators shall be of high quality synthetic rubber with anti-ozone and anti-oxidant additives.

- F. Design and treat vibration isolators for resistance to corrosion. Furnish phosphatized steel components with epoxy powder paint coating. Components exposed to the weather shall be epoxy powder paint coated or hot-dipped galvanized. Furnish zinc electroplated nuts, bolts and washers. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer.
- G. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind loads of 30 lbs/sq.ft. Wind loading shall be applied to all exposed surface of the isolated equipment in order to identify worst case load.
- H. Height savings brackets used with isolators having 2.5 inch deflection or greater shall be of the precompression type to limit exposed bolt length.
- I. All spring isolators shall be completely stable in operation and shall be designed for not less than 50 percent reserve deflection beyond actual operating conditions. All spring isolators must be completely stable in operation and have a Kx/Ky ratio of at least 1:1.
- J. All isolation materials and flexible connectors shall be of the same manufacturer and shall be selected and certified using published or factory certified data. Any variance or non-compliance with these specification requirements shall be corrected by the contractor at no additional cost to the Owner. Manufacturer may purchase other manufactured products in order to meet this specification and shall guarantee outsourced product as a single point of responsibility. Outsourced products must be identified as such in the submittal for approval.
- K. The contractor and manufacturer of the isolation and equipment shall refer to the isolator schedule which lists isolator types and isolator deflections.
- L. Deflection table is based on maintaining rooms at the following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE and ANSI S1.8.
 - 1. Offices
Executive: 30
Conference rooms: 30
Private: 35
Open-plan areas: 35
Computer/business machine areas: 40
Public circulation: 40
 - 2. Schools
Lecture and classrooms: 30
Open-plan classrooms: 35
 - 3. Libraries: 25
 - 4. Theaters
Theater: 25
Stage house: 25
Trap room: 25
Orchestra pit: 25
Rehearsal rooms: 25
Teaching studios: 30
Practice rooms: 30
Ensemble rooms: 30

Shop: 45

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, materials, thickness, dimensional data, and layout as well as connection details.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating materials and dimensional data. All steel bases and concrete inertia bases shall be completely detailed. Include clearly outlined procedures for installing and adjusting the isolators.
- D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.
- E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- F. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- G. Manufacturer's Field Reports: Indicate vibration isolation installation is complete and in accordance with instructions. Provide a copy of field report to Architect/Engineer.

1.4 QUALITY ASSURANCE

- A. The vibration isolation manufacturer, or qualified representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Vibration isolation manufacturer shall also inspect vibration isolation in units with factory provided isolation in order to confirm scheduled deflection and isolator type is in accordance with this specification. Upon completion of the installation and after the system is put into operation, the manufacturer, or representative, shall make a final inspection and submit his report to the Architect and Engineer in writing certifying the correctness of installation and compliance is in accordance approved submittal data.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATOR TYPES

All vibration isolators described in this section shall be the product of a single manufacturer. .
Submittals and certification sheets shall be in accordance with Specification 1.3 of this section.

- A. Type WSW: Two layers of 3/8-inch thick neoprene pad consisting of square waffle modules separated horizontally by a 16-gauge galvanized shim. Where the load bearing area of the equipment is not the same size/shape as the load bearing area/shape of the pad, load distribution plates, minimum 1/4" thick galvanized steel, shall be utilized to

- ensure the load bearing capacity of the pad is maximized. Pads shall be sized for approximate deflection of 0.12 inch to 0.16 inch.
- B. Type ND: Neoprene mountings shall have minimum static deflection of 0.35 inch. All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes on the bottom and a tapped hole with a mounting bolt and washer shall be provided. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Where the load bearing area of the equipment or support structure is not the same size/shape as the load bearing area/shape of the pad, load distribution plates, minimum 1/4" thick galvanized steel, shall be utilized to ensure the load bearing capacity of the pad is maximized.
 - C. Type SLF: Spring isolators shall be free-standing and laterally stable without any housing and complete with a steel-washer-reinforced molded neoprene cup of 1/4-inch neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have minimum additional travel to solid equal to 50 percent of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
 - D. Type SLR: Restrained spring mountings shall have an SLF mounting as described in Specification 2.1 C, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2 inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position under outdoor equipment, there must be an internal isolation pad in addition to the friction pad on bottom.
 - E. Type HD: Hangers shall consist of rigid steel frames containing minimum 1-1/4-inch thick neoprene element. The neoprene element shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers.
 - F. Type 30N: Hangers shall consist of rigid steel frames containing minimum 1-1/4-inch thick neoprene elements at the top and a steel spring as described in 2.1 C, seated in a steel-washer-reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30-degree arc from side to side before contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30-degree capability.
 - G. Type PC30N: Hangers shall be as described in Specification 2.1 F, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic up stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30-degree capability.

- H. Type WBI/WBD: Horizontal thrust restraints shall consist of a spring element in series with a neoprene molded cup, as described in paragraph 2.1 C, with the same deflection as specified for the mountings or hangers supporting the unit. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4-inch movement at start and stop. The assembly shall be furnished with a rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit.

Type SLR-MT: Restrained air spring mountings shall be manufactured with upper and lower steel sections connected by a replaceable flexible DuPont Kevlar reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. Restrained air springs shall be within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2 inch {12mm} shall be maintained around restraining bolts and between the housing and the air springs so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Air spring systems shall be connected to a supplementary air supply compressor (supplied with the air spring system) through a Mason Industries air spring control panel and equipped with three leveling valves to maintain level within plus or minus 0.125". Air spring mounts are to be located between the supporting steel and the roof or the grillage and dunnage as shown on the drawings when there is no provision for direct mounting. Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.

2.2 BASES

- A. Type WF: A welded integral structural steel fan and motor base with NEMA standard motor slide rails and holes drilled to receive the fan and motor slide rails. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split-case pumps shall be large enough to support suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height-saving brackets shall be employed in all mounting locations to maintain a 1-inch operating clearance under base. .
- B. Type ICS: Vibration isolation manufacturer shall provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base. Members shall have sufficient rigidity to prevent misalignment of equipment.
- C. Type RBMK. Vibration isolation manufacturer shall furnish structural steel concrete pouring forms for floating concrete bases. Wood formed bases, formed steel bases and sheet metal formed bases are not acceptable. Bases for split-case pumps shall be large enough to provide for suction and discharge elbows. Bases may be T or L shaped where space is a problem. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2-inch bars welded in place on 6-inch centers running both ways in a layer 1-1/2 inches above the bottom. Forms shall

be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Recessed height-saving brackets shall be employed in all mounting locations to maintain a 1-inch operating clearance under base.

2.3 FLEXIBLE PIPE CONNECTIONS

- A. Type SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR: Flanged and threaded rubber flexible joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 1-1/2" through 14" shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" may be single sphere. Sizes 3/4" through 2" may have one sphere, bolted threaded flange assemblies and cable retention. Minimum ratings through 14" shall be 250psi at 170°F and 215psi at 250°F, 16" through 24" 180psi at 170°F and 150psi at 250°F. Higher published rated connectors may be used where required. Safety factors shall be a minimum of 3/1. All flexible joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment. The piping gap shall be equal to the length of the flexible joint under pressure. Control rods passing through 1/2" thick Neoprene washer bushings large enough to take the thrust at 1000psi of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the flexible joint rating without them. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Isolators shall be installed as recommended by the manufacturer. Isolate all mechanical equipment 0.5 hp and over per the isolation schedule and these specifications.

3.2 PIPING ISOLATION

- A. Horizontal Pipe Isolation: All pumped water, pumped condensate and refrigerant piping size 1-1/4 inch and larger within mechanical rooms and on pipe size 2 inch and larger outside mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50 feet or 100 pipe diameters from externally isolated equipment. For the first 3 support locations from externally isolated equipment provide Type 30N hangers or Type SLF floor mounts with the same deflection as equipment isolators. All other piping within the equipment rooms shall be isolated with the same specification isolators with a 1" inch minimum deflection. Install piping hangers at regular intervals according the pipe hanger schedule. Where floor supports are required, provide sufficient spring capacity to absorb expansion and contraction of piping, and yet to permit piping to function as a floating system. Size hangers for 200 percent rated load. Coordinate selection of piping supports with equipment supports to accommodate expansion and contraction without creating excessive stresses at equipment connections.
- B. Pipe Riser Isolation: All vertical pipe risers 1-1/4 inch and larger, where specifically shown and detailed on riser drawings shall be fully supported by Type SW SLF isolators with brackets. Refer to details on Drawings. Steel spring deflection shall be 3/4 inch minimum. In locations where added deflection is required due to pipe expansion/contraction, the spring deflection shall be a minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Provide Type SWS wall sleeves. In addition to submittal

data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the piping system has been examined for excessive stresses and that none will exist in the design proposed.

3.3 INSTALLATION

- A. Comply with manufacturer's instructions for the installation and load application of vibration isolation materials and products. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation or shipment.
- B. Locate isolation hangers as near the overhead support structure as possible.
- C. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
- D. Install isolated inertia base frames and steel bases on isolator units as indicated so that a minimum of one (1) inch clearance below base will result when supported equipment has been installed and loaded for operation.
- E. Install Work in accordance with ASME B31.9.
- F. Install flexible pipe connectors to equipment supported by vibration isolation. Provide line size flexible connectors.
- G. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.
- H. Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- I. Contractor shall install load distribution plates provided by vibration isolation manufacturer on WSW type isolators. Plates shall be aligned with isolation pad.

| EQUIPMENT ISOLATION SCHEDULE | | | | | | |
|--|-------------------------------|---|------------------------------|-------------------------------|---|------------------------------|
| EQUIPMENT | LOCATION | | | | | |
| | ELEVATED STRUCTURE | | | SLAB ON GRADE | | |
| | ISOLAT OR TYPE | MINIMUM DEFLECT ION (Inches) | BASE (1) TYPE | ISOLAT OR TYPE | MINIMUM DEFLECT ION (Inches) | BASE (1) TYPE |
| CENTRIFUGAL FANS CL. I & II UP TO 54-1/2" W.D. Up to 15 HP 20-50 HP 60 HP & OVER CL. I & II 60" W.D. & OVER/ALL CL. III FANS UP TO 15 HP 20-50 HP 60 HP & OVER | SLF | 0.75 | WF | SLF | 0.75 | WF |
| | SLF | 1.5 | RBMK | SLF | 0.75 | WF |
| | SLF | 2.5 | RBMK | SLF | 1.5 | WF |
| | SLF/W | 1.5 | RBMK | SLF/W | 0.75 | RBMK |
| | BI | 2.5 | RBMK | BI | 1.5 | RBMK |
| | SLF/W | 2.5 | RBMK | SLF/W | 1.5 | RBMK |
| | BI | | | BI | | |
| | SLF/W | | | SLF/W | | |
| | BI | | | BI | | |
| | BI | | | BI | | |
| AXIAL-FLOW FANS (NOTE 1) FLOOR MTD. UP TO 15 HP 20 HP & OVER SUSPENDED (NOTE 1) UP TO 15 HO 20 HP & OVER | SLF | 0.75 | - | SLF | 0.75 | - |
| | SLF | 1.5 | - | SLF | 0.75 | - |
| | 30N | 1 | - | 30N | 1 | - |
| | PC30N | 1.75 | WF | PC30N | 1.5 | - |
| | | | | | | |
| AIR COOLED CONDENSERS UP TO 50 TONS OVER 50 TONS | SLR | 0.75 | (1) | WSW | 0.15 | - |
| | SLR | 1.5 | (1) | WSW | 0.15 | - |
| ROOFTOP AIR CONDITIONING UNITS REQUIRING WEATHER SEAL UP TO 5000 CFM (12 TON) OVER 5000 CFM (12 TON) OTHER TYPES UP TO 25 TONS OVER 25 TONS | SLF | 0.75 | RSC/C | - | - | - |
| | SLR | 1.5 | MAB | - | - | - |
| | SLR | 1.5 | RSC/C | - | - | - |
| | SLR | 1.5 | MAB | - | - | - |
| | | | (1) | | | |
| | | | (1) | | | |
| | | | | | | |

Notes:

1. Provide steel base type WF if equipment requires base frame or does not include integral base rail for vibration isolation.
2. Provide WSW isolator type with load distribution plate for floor mounted AHU's that are internally isolated. Isolation deflection and type specified refers to factory isolation requirements.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Tags.
 - 3. Stencils.
 - 4. Pipe markers.
 - 5. Ceiling tacks.
 - 6. Labels.
 - 7. Lockout devices.
 - 8. Pipe painting (if required)
- B. Related Sections:
 - 1. Section 09 91 00 - Painting and Staining.
- C. Color scheme for identification must be coordinated with district standards. Color scheme specified is bases of design if required for project. Contractor shall confirm painting requirements with Architect/District.

1.3 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.
 - 2. District Standards for identification and color scheme.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturers catalog literature for each product required.
- B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Identify painting requirements as directed by Architect/District. Contractor to confirm if painting of piping is required for project. Contractor shall provide primer coat on un-insulated outdoor condenser water piping as a minimum.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.6 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- B. Conform to ANSI / OSHA Pipe Marking Specifications.
- C. Specification is not limited to manufacturers listed. Substitutions are allowed in accordance with Division 1 - General Requirements and Division 23, Section 23 05 00 - Common Work Results for HVAC.

1.7 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
 - 4. Almetek Industries.
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Plastic Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - 2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches.
- B. Metal Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.

- d. Almetek Industries.
- 2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- C. Information Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chart: Typewritten letter size list of applied tags and location in plastic laminated chart to indicate valve make, size, model and service.

2.3 STENCILS

- A. Manufacturers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to two (2) inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
 - 2. 2-1/2 to six (6) inches Outside Diameter of Insulation or Pipe: one (1) inch high letters.
 - 3. Over six (6) inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
 - 4. Ductwork and Equipment: 1-3/4 inches high letters.
- C. Stencil Paint: As specified in Section 09 91 00 Paintings and Staining, semi-gloss enamel, colors and lettering size in conformance with ASME A13.1.

2.4 PIPE MARKERS

- A. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- B. Plastic Tape Pipe Markers:
1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- C. Plastic Underground Pipe Markers:
1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 2. Bright colored continuously printed plastic ribbon tape, minimum six (6) inches wide by 4 mil thick, manufactured for direct burial service.

2.5 CEILING TACKS

- A. Manufacturers:
1. Craftmark Identification Systems.
 2. Safety Sign Co.
 3. Seton Identification Products.
 4. Almetek Industries.
- B. Description: Steel with 3/4 inch diameter color-coded head.

2.6 LABELS

- A. Manufacturers:
1. Craftmark Identification Systems.
 2. Safety Sign Co.
 3. Seton Identification Products.
 4. Almetek Industries.
- B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

- A. Lockout Hasps:
1. Manufacturers:
 - a. Craftmark Identification Systems.
- IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 53 - 4

- b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
- 2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
- B. Valve Lockout Devices:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - 2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 91 00 Paintings and Staining for stencil painting.

3.2 INSTALLATION

- A. Apply stencil painting in accordance with Section 09 91 00 Paintings and Staining.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain or 4 ply 0.018 smooth copper wire. Tags shall be numerically sequenced with all valves of each system type grouped together.
- F. Install underground plastic pipe markers six (6) to eight (8) inches below finished grade, directly above buried pipe.
- G. All exterior visible piping shall be identified with UV and acid resistant outdoor pipe markers.
- H. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify air terminal units and radiator valves with numbered tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.

- L. Identify insulated piping, concealed or exposed indoor with plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Use plastic pipe UV protected markers on exterior piping. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification at every 20 feet on center for straight runs including risers and drops. Locate identification adjacent to each valve and tee, at each side of penetration of wall or enclosure, and at each obstruction.
- M. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment. Coordinate with Architect.
- N. Identify un-insulated piping with plastic pipe markers. Locate identification at every 20 feet on center for straight runs including risers and drops. Locate identification adjacent to each valve and tee, at each side of penetration of wall or enclosure, and at each obstruction.

3.3 IDENTIFICATION SCHEDULE

- A. Markers shall be colored as indicated below per ANSI/OSHA Standards OR as specified in District Standards:

| SYSTEM | COLOR | LEGEND |
|---------------------------|--------|---------------------------|
| Domestic Water | Green | Domestic Water |
| Domestic Hot Water Supply | Yellow | Domestic Hot Water Supply |
| Domestic Hot Water Return | Yellow | Domestic Hot Water Return |
| Fire Protection | Red | Fire Protection |
| Automatic Sprinkler | Red | Fire Sprinkler |
| Gas | Yellow | Natural Gas |

B. PIPE PAINTING:

1. All piping exposed to view in conditioned spaces shall be painted as indicated or as directed by the Architect in the field. Confirm all color selections and painting requirements with Architect/District prior to installation.
2. The entire fire protection piping system shall be painted red.
3. All outdoor un-insulated piping shall be painted with primer as a minimum.
4. All piping located in mechanical rooms and outdoor piping shall be painted as indicated in Painting Schedule. Painting requirement must be confirmed by contractor.

C. PAINTING SCHEDULE

| SYSTEM | COLOR |
|--------------------------------------|--------------|
| Storm Sewer | White |
| Sanitary Sewer Waste and Vent | Light Gray |
| Domestic Cold Water | Dark Blue |
| Domestic Hot Water Supply and Return | Orange |
| Gas | Yellow |
| Chilled Water Supply and Return | Light Blue |

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of Hydronic piping systems
3. Testing, adjusting, and balancing of refrigerating systems.
4. Measurement of final operating condition of HVAC systems.
5. Sound measurement of equipment operating conditions.
6. Vibration measurement of equipment operating conditions.

B. Related Sections:

1. Sequences of operation for HVAC equipment as scheduled on Drawings.

C. Testing, Adjusting and Balancing (TAB) contractor shall bid work specified under this section direct to Owner. TAB contractor shall not be hired by general contractor or any sub-contractor.

D. Mechanical contractor is responsible for coordinating work with the TAB Contractor. Mechanical contractor requirements are specified herein.

E. TAB Contractors:

1. Engineered Air Balance
2. Precision Air

1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- B. Engineer and Technicians Data: Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed to be used for this project.
- D. Sample Forms: Submit sample forms, if other than those standard forms, if other than those standard forms prepared by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) are proposed.
- E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
 - 1. Draft Reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit two (2) complete sets of draft reports. Only one (1) complete set of draft reports will be returned.
 - 2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit two (2) complete sets of final reports.
 - 3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binder. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs.
 - a. General Information and Summary
 - b. Air Systems
 - c. Refrigerant Systems
 - d. Temperature Control Systems
 - e. Special Systems.
 - 4. Report Contents: Provide the following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, the Company, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal name address, telephone

number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

- b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- c. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six (6) months prior to starting the project.

1.4 QUALITY ASSURANCE

- A. Test and Balance Engineer's Qualifications: A Professional Engineers registered in the State in which the services are to be performed, and having at least three (3) years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.
- B. Agency Qualifications:
 - 1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to the test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
 - 2. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB or AABC as a Test and Balance Engineer.
- C. Codes and Standards
 - 1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
 - 2. AABC: "National Standards for Total System Balance."
 - 3. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) ASHRAE Handbook, 1999 HVAC Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.
- D. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of the system operation and readiness for testing, adjusting, and balancing.

1.5 PROJECT CONDITIONS

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.6 SEQUENCING AND SCHEDULING

- A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.
- B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within five (5) degrees Fahrenheit wet bulb temperature of maximum summer design condition, and within ten (10) degrees Fahrenheit dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.
- C. Notice: Provide minimum 7 days advanced notice for each test. Include scheduled test dates and times.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 SERVICES OF THE MECHANICAL CONTRACTOR

- A. Examine the contract documents to become familiar with Project requirements and to discover conditions in systems design that may preclude proper TAB of systems and equipment.
- B. Examine the approved submittals for HVAC systems and equipment.
- C. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balancing valves are open.
 - 16. Re-sheave

- D. Contractor shall provide all volume dampers, balancing dampers, balancing valves, test ports and Pete's plugs as required by the Testing and Balancing Firm. Contractor shall furnish a set of sheet metal shop drawings and HVAC piping drawings to the Testing and Balancing Firm during the submittal phase and incorporate the Testing and Balancing Firm's mark-ups and requests into the project. Contractor shall provide all required equipment to facilitate Testing and Balancing Firm's work. This coordination shall be included in the Contractor's base bid price.
- E. Provide, correct, repair or replace deficient items or conditions found during the testing and balancing.
- F. Provide replacement sheaves as directed by TAB Contractor to achieve scheduled air volumes.
- G. For motors with a variable frequency drive, contractor shall provide belt and sheave adjustment such that units deliver their design cfm when speed drive is at 60 hertz.

3.2 SERVICES OF THE TESTING AND BALANCING CONTRACTOR

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.
- C. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 INSTALLATION TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust fans and Equipment with Fans: +/- 5%
 - 2. Air Outlets and Inlets: +/- 5%
 - 3. Heating-Water Flow Rate: +/- 5%
 - 4. Cooling-Water Flow Rate: +/- 5%

3.4 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries in clean rooms.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from construction manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR DUAL-DUCT SYSTEMS

- A. Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.
- B. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
1. If insufficient static pressure exists, increase airflow at the fan.
- C. Test and adjust the constant-volume mixing boxes as follows:
1. Verify both hot and cold operations by adjusting the thermostat and observing changes in air temperature and volume.
 2. Verify sufficient inlet static pressure before making volume adjustments.
 3. Adjust mixing boxes to indicated airflows within specified tolerances. Measure airflow by Pitot-tube traverse readings or by measuring static pressure at mixing-box taps if provided by mixing-box manufacturer.
- D. Do not over pressurize ducts.
- E. Re-measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.

- F. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume, dual-duct systems; adjust maximum- and minimum-airflow setting of each mixing box.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - b. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 - 8. Record final fan-performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Balance variable-air-volume systems the same as described for constant-volume air systems.

2. Set terminal units and supply fan at full-airflow condition.
 3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.
 7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.9 PROCEDURES FOR DOMESTIC HOT WATER SYSTEMS

- A. The test and balance contractor shall provide testing, adjusting and balancing of the hot water system, once the system is fully installed and operational. Preliminary and final reports shall be prepared and issued to the General Contractor, Architect and Engineer.
- B. Preparation of the hot water system for balancing:
 - 1. Confirm outlet temperature of the system at water heaters and/or storage tanks.
 - 2. Verify recirculation pump operation and rotation.
 - 3. Confirm/adjust setpoint of each individual riser balancing valve to flow a minimum of 0.5 gpm or as otherwise noted on the documents.
- C. The test and balance report shall indicate the following:
 - 1. Pressure, temperature and flow in gpm at the discharge side of each balancing valve referencing the valve tag number.
 - 2. Pressure, temperature and flow in gpm at the suction side of each circulating pump.

3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.12 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).

G. Gas Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h (kW).
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg (Pa).
 - f. Leaving-air static pressure in inches wg (Pa).
 - g. Air static-pressure differential in inches wg (Pa).
 - h. Low-fire fuel input in Btu/h (kW).
 - i. High-fire fuel input in Btu/h (kW).
 - j. Manifold pressure in psig (kPa).
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h (kW).
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h (kW).
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).

- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig (Pa).
- J. Air-Terminal-Device Reports:
1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig (kPa).
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. Vibration Test:
 1. Location of points:
 - a. Fan bearing, drive end
 - b. Fan bearing, opposite end
 - c. Motor bearing, center (when applicable)
 - d. Motor bearing, drive end
 - e. Motor bearing, opposite end
 - f. Casing (bottom or top)
 - g. Casing (side)
 - h. Duct after flexible connection (discharge)
 - i. Duct after flexible connection (suction)
 2. Test readings:
 - a. Horizontal, velocity and displacement
 - b. Vertical, velocity and displacement
 - c. Axial, velocity and displacement
 - d. Normally acceptable readings, velocity and acceleration
 - e. Unusual conditions at time of test
 - f. Vibration source (when non-complying)
- M. Instrument Calibration Reports:
 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Insulation systems for sheet metal duct conveying cold, hot and grease latent air.

1.2 SYSTEM DESCRIPTION

- A. Design Requirements: Provide duct insulation systems which have been manufactured, fabricated and installed to meet all thermal requirements of mechanical systems. Insulating systems shall be installed in strict accordance with manufacturer's field requirements and the current International Energy Conservation Code including all local amendments and criteria specified herein.
- B. Performance Requirements: Provide duct insulation systems which have been manufactured and installed to meet the following standards:
- C.
 - 1. NFPA 90A.
 - 2. NFPA 90B.
 - 3. UL 723, ASTM E84: Flamespread 25, smoke developed 50.
 - 4. ASTM C1136: 150 degrees F.
 - 5. ASTM C1290.
 - 6. UL 181 for Class I Air Duct.
 - 7. NAIMA AHS-152T.

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. When manufacturer's cut sheets apply to a product series rather than a specific product, clearly indicate applicable data by **highlighting** or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show specific pertinent performance data and quantities appropriate to scope of work
- C. Submit manufacturer's product data and installation instructions.
- D. Provide drawings indicating typical duct insulation details, thickness and location. Identify areas and required insulation.
- E. Manufacturer's certificate that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Utilize an installer having demonstrated five (5) years experience on projects of similar size and complexity.
- B. Condensation on any insulated system is not acceptable. Contractor shall replace insulation deemed unacceptable due to exposure to condensation at no additional cost to project.

- C. Insulation to provide minimum R-value in accordance with current International Energy Conservation Code including all local amendments and criteria specified herein.

1.5 DELIVERY, STORAGE & HANDLING

- A. Deliver insulation materials in manufacturer's original, unopened containers with identification labels intact.
- B. Contractor shall adequately protect insulation from damage after delivery to the project. Materials shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver materials to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Fiber Glass Insulation:
 - 1. Owens Corning
 - 2. Johns Manville
 - 3. Knauf Fiber Glass
 - 4. Certainteed Insulations
- B. Mastics, Adhesives and Mesh:
 - 1. Childers
 - 2. Foster
 - 3. Vimasco

2.2 DUCT WRAP

- A. Material: Resilient blanket of fiberglass insulation factory laminated to foil/kraft vapor retarder facing.
- B. Density: 0.75 pounds per cubic foot.
- C. Installed minimum R value: 8.3.
- D. Nominal Thickness: 3.0 inches.
- E. Installed Thickness: 2-1/4 inches.

- F. Operating Temperature (ASTM C411): up to 250° Fahrenheit.
- G. Insulation Jacket Temperature Limit (ASTM C1136): up to 150° Fahrenheit.
- H. Water Vapor Sorption (ASTM C1104): < 3 percent by weight at 120° Fahrenheit, 95% RH.
- I. Fungi Resistance (ASTM 665): Comply with requirements.
- J. Bacteria Resistance (ASTM G22): Comply with requirements.
- K. Thermal Conductivity: $k = 0.27$
- L. Surface Burning Characteristics (ASTM E84): Flamespread 25, smoke developed 50.

2.3 ACOUSTICAL FLEXIBLE DUCT LINER:

- A. Material: Flexible blanket of glass fibers with a tough, fire-resistant anti-microbial, acrylic coating on the airstream side to resist damage during installation and in service.
- B. Density: 1.0 pounds per cubic foot.
- C. Nominal Thickness: 1-1/4 inches.
- D. Material Standards: Comply with NFPA 90A, NFPA 90B, and ASTM C1071.
- E. Operating Temperature (ASTM C411): 250 degrees Fahrenheit.
- F. Maximum Air Velocity (UL 181): 6000 ft/m.
- G. Water Vapor Sorption (ASTM C1104): < 3 percent by weight at 120 degrees Fahrenheit, 95 percent RH.
- H. Fungi Resistance (ASTM G21): Comply with requirements.
- I. Bacteria Resistance (ASTM G22): Comply with requirements.
- J. Corrosiveness (ASTM C665): Will not cause corrosion greater than that caused by sterile cotton on aluminum or steel.
- K. Thermal Conductivity k , (ASTM C518): 0.27
- L. Surface Burning Characteristics (UL 723/ULC-S102-M): Flamespread 25, Smoke developed 50.

2.4 ACOUSTICAL RIGID DUCT LINER

- A. Material: Acoustical insulation applied to interior of sheet metal ducts. Semi-rigid board of glass fibers with a tough, fire-resistant, anti-microbial, acrylic coating on the airstream side. Factory applied edge coating. Duct liner for rectangular and round duct as required.
- B. Density: 3 pounds per cubic foot.
- C. Nominal Thickness: 1-1/2 inch.

- D. Material Standards: Comply with NFPA 90A, NFPA 90B, and ASTM C1071.
- E. Water Vapor Sorption (ASTM C1104): < 3 percent by weight at 120 degrees Fahrenheit, 95 percent RH.
- F. Fungi Resistance (ASTM C1338): Comply with requirements.
- G. Bacteria Resistance (ASTM G22): Comply with requirements.
- H. Corrosiveness (ASTM C665): Will not cause corrosion greater than that caused by sterile cotton on aluminum or steel.
- I. Thermal Conductivity, k: 0.16.
- J. Surface Burning Characteristics (UL 723/ULC-S102-M): Flamespread 25, smoke developed 50.

2.5 ACCESSORIES

- A. Pressure-Sensitivity Aluminum Foil Tapes:
 - 1. Material Standard: Listed and labeled under UL 181A, Part I, identified by name, date of manufacture, product name/number and UL 181A.
 - 2. Size: At least 2-1/2 inches wide.
- B. Heat-Activated Tapes:
 - 1. Material Standard: Listed and labeled under UL 181A, Part II, identified by name, date of manufacture, product name/number and UL 181A, may be used in all applications except for bonding to sheet metal.
 - 2. Size: At least three (3) inches wide.
- C. Mastic and Glass Fabric System:
 - a. Material Standard: Listed and labeled under UL 181A, Part III.
 - b. Size: At least three (3) inches wide.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- A. Comply with the instructions and recommendations of the duct insulation manufacturer.

3.2 INSTALLATION

A. ACOUSTICAL LINING OF SHEET METAL DUCT AND FITTINGS:

- 1. Completely cover all portions of duct designated to receive duct liner with duct liner material. Neatly butt all transverse joints with no interruptions or gaps. The black pigmented or mat faced surface of the duct liner shall face the airstream.
- 2. Affix duct liner to the sheet metal with 90 percent coverage of adhesive complying with the requirements of ASTM C916. All exposed leading edges and transverse joints shall be factory coated or coated with adhesive during

fabrication.

3. Secure duct liner with mechanical fasteners, either weld-secured or impact-driven. Compress the duct liner sufficiently to hold it firmly in place. Adhesive bonded pins are not permitted. Space mechanical fasteners with respect to duct liner interior width as follows:
 - a. Maximum spacing for mechanical fasteners where air velocity is 0 – 2,500 FPM is as follows:
 1. From transverse end of liner: three (3) inches.
 2. Across width of duct: 12 inches on center.
 3. From corners of duct: four (4) inches.
 4. Along length of duct: 18 inches on center.
 - b. Maximum spacing for mechanical fasteners where air velocity is 2,501 – 5,000 FPM is as follows:
 1. From transverse end of liner: three (3) inches.
 2. Across width of duct: six (6) inches on center.
 3. From corners of duct: four (4) inches.
 4. Along length of duct: 16 inches on center.
4. Provide galvanized metal clips on all leading edges of duct liner. Exposed insulation is not acceptable.
5. Cut duct liner to ensure overlapped and compressed longitudinal corner joints.
6. Cut duct liner board to ensure tight, overlapped corner joints. Support the top pieces of liner board at the edges by the side pieces.
7. If the specification requires use of multiple insulation layers, take the following additional steps:
 - a. Affix bottom layer of duct liner in normal manner.
 - b. Affix top layer of duct liner to bottom layer using a minimum of 90% adhesive coverage.
 - c. Treat the leading edges of the duct liner with galvanized angle clips to prevent separation of the 2 layers.
 - d. Use mechanical fasteners of the proper length for the double layer.
8. Application: Provide duct liner as follows:
 - a. Provide duct liner in first 10 feet of duct from roof mounted exhaust fans.
 - b. Provide duct liner in all return air boots and transfer ducts.

B. THERMAL INSULATION WRAP ON DUCT AND FITTINGS:

1. Before applying duct wrap, air ducts must be clean, dry and tightly sealed at all joints and seams.
2. All portions of duct designated to receive duct wrap shall be completely covered with duct wrap.

3. To ensure installed thermal performance, duct wrap insulation shall be cut to "stretch-out" dimensions as shown in tables in manufacturer's literature.
4. Remove a two (2) inch piece of insulation from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.
5. Install duct wrap insulation with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted with the two (2) inch stapling and taping flap overlapping. On rectangular duct, install so insulation is not excessively compressed at corners. Staple seams approximately six (6) inches on center with 1/2 inch minimum steel outward clinching staples.
6. Seal seams and joints with glass fabric and mastic. Do not use cloth duct tape of any color or finish using reclaimed rubber adhesives on duct wrap insulation. Tightly butt adjacent sections of duct wrap with the two (2) inch tape flap overlapping.
7. Where rectangular ducts are 24 inches in width or greater, additionally secure duct wrap insulation to the bottom of the duct with mechanical fasteners such as pins and speed clip washers or cuphead weld pins, spaced on 18 inch centers (maximum) to prevent sagging of insulation. Do not overly compress insulation.
8. Seal all tears, punctures and other penetrations of the duct wrap facing using glass fabric and mastic.
9. Application: Provide duct wrap as follows:
 - a. All supply duct
 - b. All outside air supply and intake duct
 - c. All return air duct
 - d. All return air plenums on air units
 - e. All intake plenums on outside air handling units
 - f. All ductwork routed in un-conditioned spaces including but not limited to: un-conditioned plenums (non-return air plenums), attics, exterior soffits, ventilated mechanical/boiler rooms and crawl spaces.

C. EXTERIOR OR INTERIOR EXPOSED DUCT

1. Duct shall be galvanized double wall insulated round or rectangular with perforated liner. Insulation shall be acrylic coated to prevent biological growth and airside erosion. Provide 2", 1.5 pcf insulation on exterior duct and 1", 1.5 pcf on interior exposed duct. Duct and fittings shall use a bolted flange with neoprene gasket at each connection. Provide factory seal at flange and duct. Visual sealant on exposed interior duct to be painted is unacceptable.
2. Round duct to be galvanized spiral lockseam type.
3. Exposed round duct shall utilize single rod hangers with angle support rings. Double rod hangers are only acceptable on concealed duct.

4. Application: Provide double wall duct as follows:
 - a. Gymnasiums
 - b. Natatoriums
 - c. Return air plenums with ducted connection to return grilles
 - d. Ducted connections to return air grilles
 - e. Any area where ductwork is exposed

3.3 FIELD QUALITY CONTROL

- A. Inspection: Upon completion of installation of the duct system and before operation is to commence, visually inspect the system and verify that it has been correctly installed.
- B. Contractor shall inspect systems during test and balance to ensure that the formation of condensation is not present. Contractor shall be responsible for damage caused by condensation.

3.4 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity on the site.

3.5 INSULATION SCHEDULE

- A. Supply and return ducts routed indoors (Ambient temperature \leq 85 degrees Fahrenheit, RH \leq 70 percent): R-8.3 (minimum).
- B. Supply, return, and exhaust ducts routed in unconditioned spaces including but not limited to: un-conditioned plenums (non-return air plenums), attics, exterior soffits, mechanical/boiler rooms and crawl spaces. (Ambient temperature \leq 95 degrees Fahrenheit, RH \leq 70 percent): R-8.3 (minimum).
- C. Supply, return and exhaust ducts routed outdoors or in spaces where temperature and relative humidity exceed that specified for unconditioned spaces: R-8.3 (minimum).
- D. R-values represent installed values.
- E. Provide multiple layers of insulation or thicker insulation to achieve R-values listed. If multiple layers are utilized, inner insulation layer shall not include vapor retarder.

END OF SECTION 23 07 13

SECTION 23 08 00 - COMMISSIONING OF HVAC SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

- A. This Section includes requirements for commissioning the Facility exterior closure, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 23, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility exterior closure systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements:

1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 91 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

END OF SECTION 23 08 00

SECTION 23 09 93 - SEQUENCES OF OPERATION FOR HVAC CONTROLS

GENERAL:

The BAS contractor shall provide all points listed under "Equipment Control Points" as well as any points required to accomplish the sequences of operation listed below. BAS Contractor shall provide new thermographics and programming for each system to accurately reflect configuration and operation. At the 11 month walk-thru, BAS contractor shall provide a DDC demonstration and re-verification of point to point control of all equipment control points and sequences with Owner and Engineer; no exceptions.

- BAS subcontractor shall provide and install all control damper actuators.
- Division 26 shall provide a dedicated 120v junction box in each electrical room for building controls. Building automation systems sub-contractor shall provide and install step down transformers from dedicated 120v junction box and run low voltage communication wiring power loops to serve all rooftop units, exhaust fans, etc.

1. VAV SINGLE ZONE AIR HANDLING UNIT WITH REHEAT

SUPPLY FAN CONTROL:

The variable speed supply fan will be started based on occupancy schedule. When the supply fan status indicates the fan started, the control sequence will be enable. The space temperature sensor input shall, through the DDC controller, modulate the speed of the supply fan as required to maintain the space temperature at the setpoint. If the unit's speed controller is reduced to below its minimum setpoint or the minimum outside air quantity falls below the minimum outside air setpoint, the supply air temperature shall be reset upward until the speed controller and/or the minimum outside air quantity is raised above the minimum setpoint. Upon a loss of airflow, the system will automatically restart.

ECONOMIZER CONTROL:

Economizer High Limit - Monitor outside air temperature and enthalpy (OA-T & OA-H) and return air temperature and enthalpy (RA-T & RA-H) and initiate economizer cycle if outside air enthalpy is lower than return air enthalpy and outside air temperature is cooler than economizer setpoint. Economizer shall increase outside air percentage to maintain leaving air setpoint (DA-T). The economizer will act as the initial stage of cooling, working in sequence with the cooling coil.

Economizer Low Limit - Economizer shall not cause unit leaving air temperature to fall below low limit setpoint (DA-T, (50°F (ADJ))).

MINIMUM OA CONTROL:

The OA damper (OAD-O) will open and close as required to maintain the minimum OA flow setpoint. The fresh air intake of the unit will be limited to prevent the preheat temperature (PH-T) from falling below the low limit setpoint (OALT-SP - 35 deg. F). When the zone CO2 sensor is higher than 1000 ppm, the OA damper shall open.

WARMUP/COOLDOWN MODE:

The warmup/cooldown mode will be initiated by the network input (WC-C). The unit will control to occupied setpoints (CLGOCC-SP & HTGOCC-SP) (78 F, 65 F) during warmup and cooldown cycles. The outside air damper shall remain closed during warmup/cooldown.

OCCUPIED MODE:

The occupancy mode will be controlled via a network input (OCC-SCHEDULE). The occupancy mode can also be overridden by a network input (OCC-OVERRIDE).

UNOCCUPIED MODE:

The unit will cycle to maintain unoccupied zone setpoints (CLGUNOCC-SP & HTGUNOCC-SP) (85 F, 60 F) during unoccupied periods.

COOLING COIL:

The cooling coil (CLG-O) will modulate to maintain the temperature setpoint. When the unit is shutdown, the cooling coil will be commanded to a preset position should the outdoor air temperature (OA-T) fall below the low outdoor air temperature setpoint (OALT-SP - 35 deg. F). Upon a loss of airflow (SF-S), the cooling coil will be off.

REHEAT COIL:

The reheat coil (RH-O) will modulate to maintain the temperature setpoint. When the unit is shutdown, the reheat coil will be commanded to a preset position should the outdoor air temperature (OA-T) fall below the low outdoor air temperature setpoint (OALT-SP - 35 deg. F).

DEHUMIDIFICATION:

On a rise in the zone humidity (ZN-H), the cooling coil output will be overridden to maintain the zone humidity below the zone dehumidification setpoint (DEHUM-SP). The reheat control will maintain the temperature at setpoint.

UNIT PROTECTION:

- Low Temperature Alarm (LT-A) - When in "Alarm", the control sequence will stop running, the valve(s) will open and the fan(s) will be disabled via a hard wired shutdown circuit.

ADDITIONAL POINTS MONITORED BY THE FMS:

- Outdoor Air Temperature (OA-T)
- Outdoor Air Humidity (OA-H)
- Mixed Air Temperature (MA-T)
- Cooling Coil Discharge Temperature (CC-T)
- Reheat Coil Discharge Temperature (RHC-T)
- Return Air Temperature (RA-T)
- Prefilter Status (PFILT-S)

2. VAV AIR HANDLING UNIT

SUPPLY FAN CONTROL:

The variable speed supply fan (SF-C) will be started based on occupancy schedule (OCC-SCHEDULE). When the supply fan status (SF-S) indicates the fan started, the control sequence will be enabled. The supply fan (SF-O) will modulate to maintain the discharge static pressure (DA-P) at setpoint (DAP-SP). Upon a loss of airflow (SF-S), the system will attempt to automatically restart until positive status is received.

ECONOMIZER CONTROL:

Economizer High Limit - Monitor outside air temperature and enthalpy (OA-T & OA-H) and return air temperature and enthalpy (RA-T & RA-H) and initiate economizer cycle if outside air enthalpy is lower than return air enthalpy and outside air temperature is cooler than economizer setpoint. Economizer shall

increase outside air percentage to maintain leaving air setpoint (DA-T). The economizer will act as the initial stage of cooling, working in sequence with the cooling coil.

Economizer Low Limit - Economizer shall not cause unit leaving air temperature to fall below low limit setpoint (DA-T, (50°F (ADJ))).

MINIMUM OA CONTROL:

The OA damper (OAD-O) will open and close as required to maintain the minimum OA flow setpoint. The fresh air intake of the unit will be limited to prevent the mixed air temperature (MA-T) from falling below the low limit setpoint (OALT-SP - 35 deg. F). When the return air CO2 sensor is higher than 1000 ppm, the OA damper shall open.

TEMPERATURE CONTROL:

The unit will control to maintain a constant discharge air temperature (DA-T).

WARMUP/COOLDOWN MODE:

The warmup/cooldown mode will be initiated by the network input (WC-C). The unit will control to occupied setpoints (CLGOCC-SP & HTGOCC-SP) (78 F, 65 F) during warmup and cooldown cycles.

OCCUPIED MODE:

The occupancy mode will be controlled via a network input (OCC-SCHEDULE). The occupancy mode can also be overridden by a network input (OCC-OVERRIDE).

UNOCCUPIED MODE:

The unit will cycle to maintain unoccupied zone setpoints (CLGUNOCC-SP & HTGUNOCC-SP) (85 F, 60 F) during unoccupied periods.

COOLING COIL:

The cooling coil (CLG-O) will modulate to maintain the temperature setpoint. When the unit is shutdown, the cooling coil will be commanded to a preset position should the outdoor air temperature (OA-T) fall below the low outdoor air temperature setpoint (OALT-SP - 35 deg. F). Upon a loss of airflow (SF-S), the cooling coil will be off.

UNIT PROTECTION:

- Low Temperature Alarm (LT-A) - When in "Alarm", the control sequence will stop running, the valve(s) will open and the fan(s) will be disabled via a hard wired shutdown circuit.
- Discharge Air High Duct Pressure Alarm (DAPHI-A) - When in "Alarm", the control sequence will stop running and the fan(s) will be disabled via a hard wired shutdown circuit.

ADDITIONAL POINTS MONITORED BY THE FMS:

- Outdoor Air Temperature (OA-T)
- Outdoor Air Humidity (OA-H)
- Cooling Coil Discharge Temperature (CC-T)
- Return Air Temperature (RA-T)
- Prefilter Status (PFILT-S)

3. CONSTANT AIR VOLUME AIR HANDLING UNIT

SUPPLY FAN CONTROL:

The constant speed supply fan (SF-C) will be started based on occupancy schedule. When the supply fan status (SF-S) indicates the fan started, the control sequence will be enabled. Upon a loss of airflow (SF-S), the system will attempt to automatically restart until positive status is received.

ECONOMIZER CONTROL:

Economizer High Limit - Monitor outside air temperature and enthalpy (OA-T & OA-H) and return air temperature and enthalpy (RA-T & RA-H) and initiate economizer cycle if outside air enthalpy is lower than return air enthalpy and outside air temperature is cooler than economizer setpoint. Economizer shall increase outside air percentage to maintain leaving air setpoint (DA-T). The economizer will act as the initial stage of cooling, working in sequence with the cooling coil.

Economizer Low Limit - Economizer shall not cause unit leaving air temperature to fall below low limit setpoint (DA-T, (50°F (ADJ))).

MINIMUM OA CONTROL:

The OA damper (OAD-O) will open and close as required to maintain the minimum OA flow setpoint. The fresh air intake of the unit will be limited to prevent the mixed air temperature (MA-T) from falling below the low limit setpoint (OALT-SP - 35 deg. F). The zone CO2 sensor (ZN-Q) will be used to reset the damper minimum position. When the zone CO2 sensor is higher than 1000 ppm, the OA damper shall open.

TEMPERATURE CONTROL:

The discharge air temperature setpoint (DAT-SP) will be reset as the zone temperature (ZN-T) changes.

WARMUP/COOLDOWN MODE:

The warmup/cooldown mode will be initiated by the network input (WC-C). The unit will control to occupied setpoints (CLGOCC-SP & HTGOCC-SP) (78 F, 65 F) during warmup and cooldown cycles.

OCCUPIED MODE:

The occupancy mode will be controlled via a network input (OCC-SCHEDULE). The occupancy mode can also be overridden by a network input (OCC-OVERRIDE).

UNOCCUPIED MODE:

The unit will cycle to maintain unoccupied zone setpoints (CLGUNOCC-SP & HTGUNOCC-SP) (85 F, 60 F) (85 deg. F & 60 deg. F) during unoccupied periods.

COOLING COIL:

The cooling coil (CLG-O) will modulate to maintain the temperature setpoint. When the unit is shutdown, the cooling coil will be commanded to a preset position should the outdoor air temperature (OA-T) fall below the low outdoor air temperature setpoint (OALT-SP - 35 deg. F). Upon a loss of airflow (SF-S), the cooling coil will be off.

REHEAT COIL:

The reheat coil (RH-O) will modulate to maintain the temperature setpoint. When the unit is shutdown, the reheat coil will be off. Upon a loss of airflow (SF-S), the reheat coil will remain in control.

DEHUMIDIFICATION:

On a rise in the zone humidity (ZN-H), the cooling coil output will be overridden to maintain the zone humidity below the zone dehumidification setpoint (DEHUM-SP). The reheat control will maintain the temperature at setpoint.

UNIT PROTECTION:

- Low Temperature Alarm (LT-A) - When in "Alarm", the control sequence will stop running, the valve(s) will open and the fan(s) will be disabled via a hard wired shutdown circuit.

ADDITIONAL POINTS MONITORED BY THE FMS:

- Outdoor Air Temperature (OA-T)
- Outdoor Air Humidity (OA-H)
- Cooling Coil Discharge Temperature (CC-T)
- Reheat Coil Discharge Temperature (RHC-T)
- Return Air Temperature (RA-T)
- Prefilter Status (PFILT-S)

1. SINGLE ZONE VAV PACKAGED ROOFTOP UNIT WITH GAS HEAT AND HOT GAS RE-HEAT

Equipment Control Points

Space Temperature – AI
Occupied Cooling & Heating Space Temperature Setpoints – (2) AO
Unoccupied Cooling & Heating Space Temperature Setpoints – (2) AO
Cooling Low & High Reset Sources – (2) AO
Supply Air Temperature – AI
Supply Air Temperature Setpoint – AO
OA Airflow measurement station – AI (Provided by Controls contractor)
Space or Return Air Carbon Dioxide (CO2) – AI
Carbon Dioxide (CO2) Minimum & Maximum Setpoints – (2) AO
Economizer Damper Position – AI
Minimum Economizer Damper Position – AO
Economizer Enable Setpoint – AO
RTU Alarm Status – DI
RTU fan status – current switch - DI
DX Cooling – AI
Electric Heating - AI
RTU start/stop – DO
Variable Frequency Drive Position – AI
Clogged Filter – DI

Zone Occupancy

The BAS will have an occupancy/vacancy schedule (adjustable via BAS front end), occupied heating/cooling set points and unoccupied heating/cooling set points assigned to it (adjustable via BAS front end). As the occupancy time approaches, an optimum start/stop program will calculate a start time based on current space temperature verses the occupied heating or cooling set point, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The BAS program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Unit Control

When the calculated start time arrives, the B.A.S. will send a signal to the RTU controller to enable the unit. A fan airflow proving switch will prove status to the RTU controller and will alarm at the central site if the switch is not made within 60 seconds (operator adjustable). There will also be a 60 second (operator adjustable) de-bounce time to prevent nuisance alarms from a bouncing switch.

Economizer

The economizer acts as the first stage of cooling and controls to the active supply air cooling setpoint. If the economizer reaches 100% open (adj.) and the supply air temperature is still above setpoint, mechanical cooling is allowed to stage and modulate while the economizer is held at the full open position.

The economizer dampers shall fully modulate the OA damper from the minimum position to 100% open and shall use the integral barometric relief damper to relieve excess building pressure.

The economizer shall be enabled whenever:

- Outside air wet bulb temperature is less than 60°F (adj.).
- The outside air temperature is 5°F less than the return air temperature.
- The supply fan status is on.

The economizer shall be disabled whenever:

- Outside air temperature rises 1°F above the economizer enable setpoint.

The outside air dampers shall close and the return air damper shall open when the unit is off.

Air Volume Demand Control Ventilation

A CO2 sensor mounted in the return air or in the space, as indicated on drawings, shall monitor the CO2 level. The RTU controller shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO2 level between 850 ppm and 1,000 ppm (all adjustable). The OA dampers minimum and maximum positions shall be determined by the T.A.B. contractor to be the positions that allow the scheduled minimum and maximum OA CFM.

During CO2 override operation of the outside air damper, the supply fan shall modulate between 75% to 100% of design airflow.

Single Zone Variable Air Volume Space Temperature Control

This controls sequence modulates the supply fan VFD to maintain the space temperature setpoint while heating or cooling capacity is modulated to maintain the supply air temperature setpoint.

A wall mounted space temperature sensor shall monitor the air temperature in the space. The space temperature sensor determines the heating or cooling mode of operation.

In the cooling mode, the scroll compressors will modulate to maintain the Cooling Leaving Air Setpoint. The supply fan VFD will begin operation at 30% and modulate between 30% and 100% as needed to maintain the space temperature within the Space Cooling Reset Window created by configuring a Space Cooling High and a Space Cooling Low Reset Source Setpoint.

In the heating mode the natural gas heater will modulate to maintain the Heating Leaving Air Setpoint. The supply fan VFD will begin operation at 50% and modulate between 50% and 100% as needed to maintain the space temperature within the Space Heating Reset Window created by configuring a Space Heating High and a Space Heating Low Reset Source Setpoint.

When the space temperature setpoint has been satisfied, the unit will operate in ventilation mode and the supply fan will operate at 30%.

Dehumidification

Factory installed hot gas reheat shall allow application of dehumidification. Dehumidification shall be allowed only when outside air temperature is above 40 degrees F and below 100 degrees F. the economizer outside air damper shall drive to minimum position during dehumidification.

Single compressor units

1. On a call for dehumidification, the reheat valve shall energize and the compressor shall enable. When the humidity control setpoint is satisfied, the valve shall de-energize and the compressor shall be disabled. If there is a call for cooling from the space temperature controller, while in reheat, the reheat valve shall be de-energize and the compressor continues to run

Dual Compressor units

1. On a call for dehumidification, the reheat valve shall energize and both compressors shall enable. When the humidity control setpoint is satisfied, the valve shall be energized and both compressors shall be disabled. If there is a call for 1st stage cooling while in the dehumidification mode, no action shall take place. If there is a call for 2nd stage cooling, the reheat valve shall be de-energized, and the unit shall revert to the cooling mode. If 2nd stage cooling is satisfied and there is still a call for dehumidification, the reheat valve shall once again be energized.

Smoke Detector Shutdown

The unit shall shut down in response to a signal from the smoke detector indicating the presence of smoke. The smoke detector shall be interlocked to the unit through the dry contact of the smoke detector. A manual reset of the smoke detector shall be required to restart the unit.

Equipment off Conditions

When the RTU is de-energized, the supply fan shall de-energize and the OA damper shall be fully closed.

2. CAV PACKAGED ROOFTOP UNIT WITH GAS HEAT

Equipment Control Points

Space Temperature – AI
Occupied Cooling & Heating Space Temperature Setpoints – (2) AO
Unoccupied Cooling & Heating Space Temperature Setpoints – (2) AO
Cooling Low & High Reset Sources – (2) AO
Supply Air Temperature – AI
Supply Air Temperature Setpoint – AO
OA Airflow measurement station – AI (Provided by Controls contractor)
Space or Return Air Carbon Dioxide (CO2) – AI
Carbon Dioxide (CO2) Minimum & Maximum Setpoints – (2) AO
Economizer Damper Position – AI
Minimum Economizer Damper Position – AO
Economizer Enable Setpoint – AO
RTU Alarm Status – DI
RTU fan status – current switch - DI
DX Cooling – AI
Electric Heating - AI
RTU start/stop – DO

Variable Frequency Drive Position – AI
Clogged Filter – DI

Zone Occupancy

The BAS will have an occupancy/vacancy schedule (adjustable via BAS front end), occupied heating/cooling set points and unoccupied heating/cooling set points assigned to it (adjustable via BAS front end). As the occupancy time approaches, an optimum start/stop program will calculate a start time based on current space temperature versus the occupied heating or cooling set point, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The BAS program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Unit Control

When the calculated start time arrives, the B.A.S. will send a signal to the RTU controller to enable the unit. A fan airflow proving switch will prove status to the RTU controller and will alarm at the central site if the switch is not made within 60 seconds (operator adjustable). There will also be a 60 second (operator adjustable) de-bounce time to prevent nuisance alarms from a bouncing switch.

Economizer

The economizer acts as the first stage of cooling and controls to the active supply air cooling setpoint. If the economizer reaches 100% open (adj.) and the supply air temperature is still above setpoint, mechanical cooling is allowed to stage and modulate while the economizer is held at the full open position.

The economizer dampers shall fully modulate the OA damper from the minimum position to 100% open and shall use the integral barometric relief damper to relieve excess building pressure.

The economizer shall be enabled whenever:

- Outside air wet bulb temperature is less than 60°F (adj.).
- The outside air temperature is 5°F less than the return air temperature.
- The supply fan status is on.

The economizer shall be disabled whenever:

- Outside air temperature rises 1°F above the economizer enable setpoint.

The outside air dampers shall close and the return air damper shall open when the unit is off.

Air Volume Demand Control Ventilation

A CO2 sensor mounted in the return air or in the space, as indicated on drawings, shall monitor the CO2 level. The RTU controller shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO2 level between 850 ppm and 1,000 ppm (all adjustable). The OA dampers minimum and maximum positions shall be determined by the T.A.B. contractor to be the positions that allow the scheduled minimum and maximum OA CFM.

During CO2 override operation of the outside air damper, the supply fan shall modulate between 75% to 100% of design airflow.

Constant Air Volume Space Temperature Control

This controls sequence turns the supply fan on/off to maintain the space temperature setpoint while heating or cooling capacity is modulated to maintain the supply air temperature setpoint.

A wall mounted space temperature sensor shall monitor the air temperature in the space. The space temperature sensor determines the heating or cooling mode of operation.

In the cooling mode, the scroll compressors will modulate to maintain the Cooling Leaving Air Setpoint. The supply fan starter will begin operation when in occupied mode to maintain the space temperature within the Space Cooling Reset Window created by configuring a Space Cooling High and a Space Cooling Low Reset Source Setpoint.

In the heating mode the natural gas heater will modulate to maintain the Heating Leaving Air Setpoint. The supply fan starter will begin operation as needed to maintain the space temperature within the Space Heating Reset Window created by configuring a Space Heating High and a Space Heating Low Reset Source Setpoint.

When the space temperature setpoint has been satisfied, the unit will operate in ventilation mode and the supply fan will operate at 30%.

Dehumidification

Factory installed hot gas reheat shall allow application of dehumidification. Dehumidification shall be allowed only when outside air temperature is above 40 degrees F and below 100 degrees F. the economizer outside air damper shall drive to minimum position during dehumidification.

Single compressor units

1. On a call for dehumidification, the reheat valve shall energize and the compressor shall enable. When the humidity control setpoint is satisfied, the valve shall de-energize and the compressor shall be disabled. If there is a call for cooling from the space temperature controller, while in reheat, the reheat valve shall be de-energize and the compressor continues to run

Dual Compressor units

2. On a call for dehumidification, the reheat valve shall energize and both compressors shall enable. When the humidity control stepoint is satisfied, the valve shall be energized and both compressors shall be disabled. If there is a call for 1st stage cooling while in the dehumidification mode, no action shall take place. If there is a call for 2nd stage cooling, the reheat valve shall be de-energized, and the unit shall revert to the cooling mode. If 2nd stage cooling is satisfied and there is still a call for dehumidification, the reheat valve shall once again be energized.

3. DUCTLESS MINI-SPLIT A/C UNITS – MDF / IDF / ELECTRICAL ROOMS

Equipment Control Points

Room temperature - AI

Unit alarm - DI

A split-system cooling unit coil shall be controlled by a microprocessor temperature sensor/controller, furnished by the unit manufacturer. The controller shall monitor the air temperature in the space. The thermostat shall energize cooling to maintain room setpoint. The BAS shall monitor the room temperature and alarm at the central site if the temperature rises above 85°F (adjustable).

4. GENERAL EXHAUST FANS (RESTROOMS, LOCKER ROOMS, ETC.)

Equipment Control Points

Exhaust fan status – Current switch - DI

Exhaust fan enable – DO

Interlock all general exhaust fans to run with rooftop unit equipment serving the same area and run only during the occupied mode with their OA Dampers open. The exhaust fans shall remain off even during the scheduled occupancy time based on a global command from a shelter in place (building shutdown) button or based on a summer mode schedule. Exhaust fans shall have motorized dampers, BAS contractor shall provide damper, actuator and necessary interlock wiring to allow damper to open whenever the exhaust fan is running.

5. THERMOSTAT CONTROLLED IN-LINE EXHAUST FANS (ELECTRICAL ROOMS)

Provide a line-voltage cooling thermostat to energize fan whenever the space temperature increases above 80°F (adjustable) setpoint.

6. CHEMICAL STORAGE ROOM EXHAUST FAN

Equipment Control Points:

Fan status - DI

The fans shall be wired to operate continuously. The BAS shall monitor status via current sensing relay. If fan stops, as sensed by current switch, the BAS shall alarm the operator.

7. CARBON MONOXIDE (CO) MONITORING

Equipment Control Points

CO Monitoring – DI

Carbon Monoxide Monitoring

A carbon monoxide sensor installed in the boiler room will alarm the BAS and shutdown the domestic water heater(s) and notify district maintenance personnel via e-mail and text message when the level of carbon monoxide rises above 100 ppm (adjustable). The sensor shall also alarm the BAS and shutdown the boiler upon loss of power to the sensor. Boiler Room supply fan will be de-energized and the emergency exhaust fan will be energized to dilute the carbon monoxide levels in the room. A strobe light and audible alarm at the panel will be activated during an event. A pushbutton on the panel will silence the alarm and reset the system. Carbon monoxide sensor shall be calibrated every eighteen months and a record of calibration shall be posted in a conspicuous place.

8. RELIEF DAMPERS

Equipment Control Points

Damper open/close - DO

The BAS contractor shall furnish dampers at each relief air opening and shall provide controls to open the dampers whenever the associated zone is in occupied mode. The dampers shall remain closed based on a global command from a shelter-in-place button or based on a summer mode schedule.

Demand Reduction Control

During a demand reduction event, this unit shall be disabled.

9. ELECTRIC UNIT HEATER

Unit Heater shall be locally controlled by a low voltage wall mounted thermostat furnished with the unit heater. BAS contractor shall mount and wire thermostat to unit heater and maintain room temperature.

10. OUTDOOR AIR CONDITIONS

Equipment Control Points

Outdoor air temperature – AI
Outdoor air humidity – AI

The sensors shall be mounted in an area on the north side of the building where the representative temperature and humidity can be monitored, both shall have sun shields. Based on the outside air temperature and humidity the BAS shall calculate the outdoor enthalpy, wet bulb, and dew point temperatures. The outdoor air temperature and humidity shall be broadcast as global information for use by the other control programs.

11. HVAC TIMED LOCAL OVERRIDE (TLO)

Equipment Control Points

Override button input – DI

A local override button located as directed by the owner shall allow temporary override of the entire system. Each press of the button shall place the system in occupied mode for 30 minutes (adjustable), to a maximum of 2 hours (adjustable).

12. INTERIOR / EXTERIOR LIGHTING CONTROL

Equipment Control Points

Lighting contactor enable/disable - DO

Lighting controllers

The BAS contractor shall provide separate outputs for each contactor indicated on the electrical drawings. Each contactor shall be able to be controlled via operator defined schedule independently or in groups defined by the operator. Provide a photocell for monitoring by the BAS. Exterior lighting shall be turned off if the photocell senses light levels above a pre-determined limit.

Contractor shall program to allow the operator to select whether the system utilizes a boundary schedule and sunrise/sunset calculations. If the exterior lights are scheduled to operate, the operator shall have the option to select to enable them for an adjustable time period before or after sunset and disable for an adjustable time period before or after sunrise.

Override

Provide a method of manual override in an easily accessible location (i.e., control relay with integral hand-off-auto in control panel).

13. LIGHTING TLO

Equipment Control Points

Override button input – DI

A local override button located as directed by owner shall allow temporary override of the interior lighting. Each press of the button shall override the system for 30 minutes (adjustable), to a maximum of 90 minutes (adjustable).

END OF SECTION 23 09 93

SECTION 23 22 00 - CONDENSATE PIPING

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section Includes: Pipe and pipe fitting materials, joining methods and pipe insulation for the following systems:
 - 1. Condensate equipment drains and over flows.
- B. Related Sections:
 - 1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports and fire stopping for placement by this section.

1.3 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.3 - Malleable Iron Threaded Fittings.
 - 2. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 3. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 4. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 5. ASME B31.1 – Power Piping.
 - 6. ASME B31.5 - Refrigeration Piping.
 - 7. ASME B31.9 - Building Services Piping.
- B. ASTM International (ASTM):
 - 1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM A536 – Standard Specification for Ductile Iron Castings.
 - 4. ASTM B32 - Standard Specification for Solder Metal.

5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- C. American Welding Society:
 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Provide flanges, union, and couplings at locations requiring servicing.
- B. Provide unions, flanges, and couplings downstream of valves and at equipment or apparatus connections.
- C. Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- D. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

1.5 ACTION SUBMITTALS

- A. Submit in accordance with Division 1 - General Requirements.
- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes. Indicate schematic layout of refrigeration system, including equipment, critical dimensions, and sizes.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
- D. Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used.
- E. Test Reports: Indicate results of refrigerant leak test and acid test.
- F. Welders' Certificate: Include welders' certification of compliance with ASME Section IX.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control test reports.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years experience.
- F. Installer: Company specializing in performing Work of this section with minimum three (3) years experience approved by manufacturer.
- G. Design piping systems under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.
- H. All pipe and accessories shall be of United States domestic manufacture.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Division 1 - General Requirements.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system Protect.
- D. Contractor shall adequately protect material from damage after delivery to the project. Piping shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.

- E. Do not deliver Piping to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WELDING

- A. Welding Procedures: Conform to latest recommendations of American Welding Society and Code for Pressure Piping, ANSI B31.1, and current edition. Welding and stress relieving procedures shall conform to Appendix, Section VI, and "Standard Qualifications for Welding Procedures, Welders and Welding Operators."
- B. Locations for Welding: Welding shall not be permitted within occupied area of the building. When the building or a portion of the building is in use as a permanent occupancy welding shall be permitted only in areas physically separated from occupied spaces by fire rated or non-combustible walls to deck or on completely gutted and unoccupied floors.
- C. Fire Protection and Smoke Venting: The Contractor shall provide all manpower and equipment required to protect the building structure and site occupants, other Contractors, etc., from hazards and to remove welding fumes from the building conform to the latest requirements of NFPA 51B.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type B).
- B. Wrought-Copper Fittings: ASME B16.22.
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - A. Anvil International, Inc.
 - B. S. P. Fittings; a division of Star Pipe Products.
 - C. Victaulic Company.
- C. Copper or Bronze Pressure-Seal Fittings:
 - 1. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - A. Stadler-Viega.
 - 2. Housing: Copper.
 - 3. O-Rings and Pipe Stops: EPDM.
 - 4. Tools: Manufacturer's special tools.
 - 5. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

- D. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Seamless galvanized steel with plain ends; schedule 40, 0.375 inch wall.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150.
- E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

2.3 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - A. Capitol Manufacturing Company.
 - B. Hart Industries International, Inc.
 - C. Jomar International Ltd.
 - D. Matco-Norca, Inc.
 - E. McDonald, A. Y. Mfg. Co.
 - F. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - G. Wilkins; a Zurn company.
 - 2. Description:
 - A. Standard: ASSE 1079.
 - B. Pressure Rating: 125 psig minimum at 180 deg F.
 - C. End Connections: Solder-joint copper alloy and threaded ferrous.

2.5 PIPING INSULATION

- A. High density factory molded fiberglass insulation with factory applied, all service, and reinforced vapor retarder jacket. Provide with a factory applied pressure sensitive tape closure system and matching butt strips. 1" thick for all pipe sizes and locations.
 - 1. Thermal conductivity "k" of 0.23 of Btu-in / hr-sq.ft. Degree F at 75 degree mean temperature.
 - 2. Maximum jacket permeance shall be 0.02.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - A. Johns Manville.
 - B. Owens Corning
 - C. Knauf.
 - D. CertainTeed
- C. Aluminum Jacket: General Requirements: Provide aluminum jacketing for all condensate drain piping located outdoors.
 - A. Jacket for piping shall be 0.016 inch thick type 3105 aluminum with factory applied one mil polykraft moisture barrier.
 - B. Fitting covers shall be factory made 0.024 inch type 1100 aluminum to match pipe covering.

PART 3 - EXECUTION

3.1 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- G. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- H. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.2 PIPING INSTALLATION

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- D. Install piping free of sags and bends.
- E. Install piping to allow application of insulation.

3.3 INSULATION INSTALLATION

- A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.
- B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.
- D. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
- E. Install insulation on piping subsequent to installation of heat tracing, painting, and acceptance tests.
- F. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
- G. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

- H. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- I. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- J. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- K. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- L. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- M. Keep insulation materials dry during application and finishing.
- N. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- O. Apply insulation with the least number of joints practical.
- P. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
- Q. Apply insulation continuously through hangers and around anchor attachments.
- R. For insulation application where vapor retarder are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- S. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- T. Insulation Terminations: For insulation application where vapor retarder is indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

END OF SECTION 23 22 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and Flat Oval ducts and fittings.
 - 3. Double-wall round and Flat Oval ducts and fittings.
 - 4. Insulated Flexible Ducts
 - 5. Sheet metal materials.
 - 6. Sealants and gaskets.
 - 7. Duct coating requirement for Natatoriums.
 - 8. Hangers and supports.
- B. Related Sections:
 - 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 3. Division 23 Section "Duct Insulation" for internal duct liner.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.

- B. Product Data: For each type of the following products:
 - 1. Adhesives.
 - 2. Sealants and gaskets.
- C. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. $\frac{1}{4}" = 1'-0"$ Scale Duct layout drawings indicating sizes, configuration, liner material, static-pressure classes, and bottom of duct elevations. Duct shop drawings shall be superimposed on the architectural backgrounds with the reflected ceiling plans.
 - 4. Dimensions of main duct runs from building grid lines.
 - 5. Fittings.
 - 6. Reinforcement and spacing.
 - 7. Seam and joint construction.
 - 8. Penetrations through fire-rated and other partitions.
 - 9. Equipment installation based on equipment being used on Project.
 - 10. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 11. Hangers and supports, including methods for duct and building attachment, and vibration isolation.
- D. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- B. Welding certificates.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports, and AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Open ends of ductwork shall be factory shrink wrapped air and water tight before shipment to jobsite.
- B. Contractor shall adequately protect ductwork from damage after delivery to the project. Ductwork shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver ductwork to the project site until progress of construction has reached the stage where ductwork is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers:
 - 1. McCorvey Sheet Metal
 - 2. DuctDirect
 - 3. Gurry Mechanical L.P.
 - 4. Letsos Company
 - 5. Mason Road Sheet Metal Inc.
 - 6. Telkin Sheetmetal, Inc.
 - 7. Tomball Sheet Metal Co.
 - 8. McGill AirFlow LLC.
 - 9. Texas Duct Systems
 - 10. SEMCO Incorporated
 - 11. Lindab Inc.
- B. Fabricate ducts with indicated dimensions for the inner duct.
- C. Sheet Metal Connectors, Inc
- D. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- G. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND AND FLAT OVAL DUCTS AND FITTINGS

- A. Manufacturers:
 - 1. McCorvey Sheet Metal
 - 2. DuctDirect
 - 3. Gurry Mechanical L.P.
 - 4. Letsos Company
 - 5. Mason Road Sheet Metal Inc.

6. Telkin Sheetmetal, Inc.
 7. Tomball Sheet Metal Co.
 8. Commercial Duct Systems, LLC
 9. Texas Duct Systems
 10. McGill AirFlow LLC.
 11. SEMCO Incorporated
 12. Lindab Inc.
- B. Fabricate ducts with indicated dimensions for the inner duct.
- C. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- D. Triple-Rib shall be acceptable for single wall spiral lockseam ducts: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
- F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
 2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
- G. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers:
1. McCorvey Sheet Metal
 2. Gurry Mechanical L.P.
 3. Letsos Company
 4. Mason Road Sheet Metal Inc.

5. Telkin Sheetmetal, Inc.
 6. Tomball Sheet Metal Co.
 7. Commercial Duct Systems, LLC
 8. Texas Duct Systems
 9. McGill AirFlow LLC.
 10. SEMCO Incorporated
 11. Lindab Inc.
- B. Fabricate ducts with indicated dimensions for the inner duct.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: $K = 0.23$ at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.

4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 1. Maximum Thermal Conductivity: $K = 0.23$ at 75 deg F mean temperature.

2.4 INSULATED FLEXIBLE DUCTS

- A. Manufacturers:
 - a. Thermaflex Type M-KE.
 - b. Atco
- B. Product Description: UL 181, Class 1, CPE fabric attached to helical wound spring galvanized steel wire; fiberglass insulation; aluminized vapor barrier film.
 - a. Pressure Rating: six (6) inches wg positive and four (4) inches wg negative.
 - b. Maximum Velocity: 4,000 fpm.
 - c. Temperature Range: -20 degrees Fahrenheit to 210 degrees Fahrenheit.
 - d. Thermal Resistance: Minimum R-6 installed.
 - e. Maximum flexible duct length shall not exceed 6'-0".
- C. Provide Flexible Duct Elbow Supports at each diffuser. Refer to "23 33 00 Air Duct Accessories"; 2.10 Flexible Duct Elbow Supports.

2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G60 (Z180).
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G60 (Z180).
 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.
 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Duct straps shall be wrapped from the top cord of joists; straps wrapped from the bottom chord will not be accepted.
- E. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- F. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- G. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- H. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- I. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.

- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- M. Ductwork installed on the roof shall be installed and supported such that the roof may be maintained / repaired without the need to disassemble any ductwork.
- N. Dryer exhaust ducts for clothes dryers shall be smooth, rigid galvanized duct and shall terminate on the outside of the building and shall be equipped with a backdraft damper. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the exhaust flow. Clothes dryer exhaust ducts shall not be connected to a vent connector, vent or chimney. Clothes dryer exhaust ducts shall not extend into or through ducts or plenums. Provide weather resistant stainless steel wall cap at duct / wall penetration and a minimum 8" relief hood at roof penetration with roof curb, flashing and counter flashing.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. For fastening of sheet metal support straps on each side of the duct, provide (2) two sheet metal screws on the side of the duct and (1) one on the bottom of the duct for a total of (6) six sheet metal screws for maximum fastening of strap to sheet metal duct.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint all exposed ductwork and exterior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer; refer to paint manufacturer's instructions to prevent peeling. Coordinate final paint color with architect. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.
 - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 6. Give seven days advanced notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.

- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA ACR 2006. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.
 2. All exposed ducts in spaces such as but not limited to; Gymnasiums, Natatoriums, and Cafeteria's: Double wall insulated round ductwork.
- B. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Split-DX System Air Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 12.
 2. Ducts Connected to Constant-Volume Air-Handling and Rooftop Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 6.
 3. Ducts Connected to Variable-Air-Volume Air-Handling and Rooftop Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round: 3.

C. Return and Outside Air Ducts:

1. Ducts Connected to Fan Coil Units, Split-DX System Air Units Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 12.
2. Ducts Connected to Air-Handling and Rooftop Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 6.
2. Ducts Connected to Air-Handling and Rooftop Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 6.
3. Ducts Connected to Shower Return air grilles:
 - a. 18 gauge Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 4 finish.
 - c. Concealed: No. 2D finish.
 - d. Continuously welded seams and joints
 - e. Pressure Class: Positive or negative 2-inch wg.
 - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - g. SMACNA Leakage Class: 3.
4. Ducts Connected to Chlorine and Acid Rooms (ASHRAE 62.1, Class 3 and 4) Air:
 - a. Type 316, stainless-steel sheet.
 1. Exposed to View: No. 4 finish.
 2. Concealed: No. 2D finish.
 - b. Continuously welded seams and joints
 - c. Pressure Class: Positive or negative 3-inch wg.
 - d. Minimum SMACNA Seal Class: A.
 - e. SMACNA Leakage Class: 3.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
4. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 1. Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1,000 fpm or Lower: 90-degree tap.
 - b. Velocity 1,000 to 1,500 fpm: Conical tap.
 - c. Velocity 1,500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 - AIR DUCT ACCESSORIES

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Combination fire-and-smoke dampers.
3. Duct access doors.
4. Fire dampers.
5. Smoke dampers.
6. Volume control dampers.
7. Flexible duct connections
8. Duct Taps
9. Duct test holes
10. Flexible duct elbow supports

B. Related Sections:

1. Section 23 31 00 - HVAC Duct and Casings: Requirements for duct construction and pressure classifications.

1.2 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
- C. Product Data: Submit data for shop fabricated assemblies including fire dampers including locations and ratings, smoke dampers including locations and ratings, backdraft dampers, flexible duct connections, volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit for Fire, Smoke and Combination Fire/Smoke Dampers.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

1.5 COORDINATION

- A. Coordinate Work where appropriate with building control Work.
- B. Coordinate fire alarm wiring requirements with Division 26.

1.6 WARRANTY

- A. Furnish five (5) year manufacturer warranty for duct accessories.

1.7 EXTRA MATERIALS

- A. Furnish two (2) of each size and type of fusible link for fire rated dampers.

PART 2 - PRODUCTS

2.1 BACK-DRAFT DAMPERS

- A. Manufacturers:
 - 1. Arrow United Industries
 - 2. American Warming and Ventilating
 - 3. Ruskin
 - 4. Air Balance
 - 5. NCA
 - 6. Pottorff
 - 7. Greenheck
- B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel, or extruded aluminum. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Cesco
 - 2. NCA
 - 3. Ruskin
 - 4. Nailor
 - 5. Pottorff
 - 6. Greenheck
- B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S. Dampers shall be Leakage Class 1. Damper shall include a factory installed sleeve.
- C. Construction: Fabricate with 16 gage roll formed, galvanized steel hat-shaped channel frame. Furnish stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, concealed linkage, and 1/2 inch actuator shaft. Blades shall be airfoil type, 14 gauge equivalent. Blade edge seals shall be mechanically fastened to blade.

- D. Operators: UL listed and labeled two-position, fail close, electric type suitable for 120 volts, single phase, 60 Hz. Furnish end switches to indicate damper position. Locate damper operator on exterior of sleeve and link to damper operating shaft.
- E. Temperature rating: 250°F.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of Electro thermal link, flexible stainless steel blade edge seals to produce constant sealing pressure.
- G. Coordinate fire alarm control wiring with Division 26.
- H. Rating: 1-1/2 hours in wall rated at less than three (3) hours.
- I. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of Electro thermal link, flexible stainless steel blade edge seals to produce constant sealing pressure, stainless steel springs with locking devices to maintain positive closure for units mounted horizontally.
- J. Electric Fuse Link: Heat actuated, quick detecting to release at 165 degrees Fahrenheit, UL listed and labeled. Controlled closing and locking of damper in 7-15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable. Manual reset at damper.

2.3 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches square, secure with sash locks.
 - 2. Up to 18 inches Square: Furnish two hinges and two (2) sash locks.
 - 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside handles.
 - 4. Larger Sizes: Furnish additional hinge.
 - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.4 FIRE DAMPERS

- A. Manufacturers:
 - 1. Cesco
 - 2. NCA
 - 3. Ruskin
 - 4. Nailor
 - 5. Pottorff
 - 6. Greenheck

- B. Fabricate in accordance with NFPA 90A and UL 555, and manufacturer's condition of listing. Permanently mark dampers for use in dynamic systems.
- C. Ceiling Fire Dampers: Galvanized steel, 24 gage frame and 24 gage blades with UL classified insulation if required. Provide with radiation blanket.
- D. Curtain Type Dampers: 20 gage Galvanized steel frame with interlocking 24 gage galvanized steel blades. Furnish stainless steel closure springs and latches for horizontal installations and closure under airflow conditions. Configure with blades out of air stream.
- E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- F. Fusible Links: UL 33, separate at 165 degrees Fahrenheit.
- G. Rating: 1-1/2 hours in wall rated at less than three (3) hours.

2.5 SMOKE DAMPERS

- A. Manufacturers:
 - 1. Cesco
 - 2. NCA
 - 3. Ruskin
 - 4. Nailor
 - 5. Pottorff
 - 6. Greenheck
- B. Fabricate in accordance with UL 555S, Leakage Class I.
- C. Construction: Fabricate with 16 gage roll formed, galvanized steel hat-shaped channel frame. Furnish self-lubricating stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, concealed linkage and 1/2 inch actuator shaft. Blades shall be airfoil type, 14 gauge equivalent. Blade edge seals shall be mechanically fastened to blade.
- D. Operators: UL listed and labeled two-position, fail close, electric type suitable for 120 volts, single phase, 60 Hz. Furnish end switches to indicate damper position. Actuator to be mounted internally or externally as required.
- E. Temperature rating: 250°F.
- F. Coordinate fire alarm control wiring with Division 26.

2.6 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.

2. Blade: Fabricate of single thickness sheet metal secured with continuous hinge or rod with end bearings.
 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- C. Single Blade Dampers: Fabricate for duct height up to 12".
- D. Multi-Blade Damper: Opposed blade interlocking type pattern for duct height 12" and greater. Assemble blades in galvanized frame channel with suitable hardware and linkage concealed in frame. Provide multiple section dampers for sizes larger than 48 inch x 72 inch. Provide jack shafting configuration and crossovers.
- E. Damper Blades:
1. Provide 16 gauge galvanized steel center and edge grooved blade type where velocities do not exceed 1500 FPM.
 2. Provide 14 gage galvanized steel. Roll formed airfoil blade type where velocities exceed 1500 FPM.
 3. Maximum leakage shall be 8 CFM per square foot of damper area at four (4) inches wg pressure.
- F. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or bronze bearings. Furnish closed end bearings on ducts having pressure classification over two (2) inches wg.
- G. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers that do not have actuators.
 2. On insulated ducts mount quadrant regulators on 2" standoff mounting brackets, bases, or adapters.
 3. Where rod lengths exceed 30 inches furnish regulator at both ends.
 4. Provide remote damper operators for concealed dampers. Operator shall utilize miter gears, worm gears and couplings or be cable operated. Coordinate operator trim and location with Architect / Engineer.
- H. Actuators:
1. Maximum damper area per actuator shall be 24 square feet face area.
 2. Actuators shall be two position or modulating spring return type.
 3. Duct mounted dampers shall have actuators mounted outside of air stream.
 4. Coordinate with Section 23 09 23 – Direct-Digital Control System for HVAC.

2.7 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 - 2. Net Fabric Width: Approximately six (6) inches wide.
 - 3. Metal: Three (3) inch wide, galvanized steel. Same gage as connecting duct.
 - 4. Install flexible connections with a minimum of one (1) inch between metal edges.
 - 5. Provide flexible duct connections at every duct connection to equipment.
- C. Application:
 - 1. Flexible duct connectors are not permitted on duct connections to internally isolated equipment. Internal isolation shall be in accordance with Section 15070.

2.8 DUCT TAPS

- A. Provide 24 gauge galvanized steel conical fittings with integral balancing damper for duct taps serving single ceiling diffuser. Balancing damper shall consist of 24 gauge, 3/8" steel axel and nylon end bearings with 2" standoff quadrant mount.
- B. Provide 24 gauge galvanized steel 45 degree, rectangular to round, side takeoff fitting with integral balancing damper when airflow is less than or equal to 20 percent of main duct airflow. Balancing damper shall consist of 24 gauge, 3/8" steel axel and nylon end bearings with 2" standoff quadrant mount.
- C. Provide tee split with radius elbow when takeoff or branch duct airflow is greater than 20 percent of main duct. Square throat elbows are acceptable in areas of limited clearances. Provide splitter damper. Refer to Section 23 31 00 - HVAC Duct and Casings.
- D. Provide volume damper at all takeoffs in constant volume systems and at all takeoffs downstream of terminal units in variable volume systems.

2.9 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.
- B. Coordinate test hole locations and requirements with TAB contractor. If additional test holes are required for TAB, contractor will provide at no additional cost.

2.10 FLEXIBLE DUCT ELBOW SUPPORTS

- A. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6" – 16". Elbow supports shall be UL listed for use in return air plenum spaces.
- B. Provide elbow supports at each diffuser connection.
- C. Manufactured by Thermaflex – FlexFlow Elbow

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify rated walls are ready for fire damper installation.
- B. Verify ducts and equipment is ready for accessories.
- C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards Metal and Flexible. Refer to Section 23 31 00 - HVAC Duct and Casings for duct construction and pressure class.
- B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside if motorized dampers are not shown on plans.
- C. Install duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and as indicated on Drawings. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.
- D. Install temporary duct test holes required for testing and balancing purposes. Cut or drill in ducts. Cap with neoprene plugs, threaded plugs, threaded or twist-on metal caps.
- E. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves and breakaway duct connections.
- F. Install smoke dampers and combination fire and smoke dampers in accordance with NFPA 92A.
- G. Install volume dampers at points on supply, return, outside air and exhaust systems where branches extend from larger ducts. For air systems with common return air plenum provide volume dampers in both outside air and return air ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
 - 3. Install stainless steel volume dampers in stainless steel ducts.
 - 4. Install aluminum volume dampers in natatoriums.

3.3 DEMONSTRATION

- A. Demonstrate re-setting of fire dampers, fire and smoke dampers and smoke dampers to Owner's representative.

END OF SECTION 23 33 00

SECTION 23 34 00 - HVAC FANS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide complete, fully operational fans where indicated on Drawings.
- B. Section Includes:
 - 1. Downblast centrifugal roof fans
- C. Related Sections:
 - 1. Section 23 31 00 - HVAC Duct and Casings - Ducts: Product requirements for hangers for placement by this section.
 - 2. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 - 3. Coordinate work in this Section with Division 7.

1.2 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, and ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705 and UL 762 for kitchen exhaust.
- D. Balance Quality: Conform to AMCA 204.

- E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.

1.5 WARRANTY

- A. Furnish one (1) year manufacturer's warranty for fans. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start date from shipment or start up will not be acceptable.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Spare materials shall be provided by equipment manufacturer and not by the installing mechanical contractor.

- 1. Fan Belts: Two (2) sets for each belt-driven fan.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Fans shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- D. Do not deliver Equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 DOWNBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers:
 - 1. Acme Engineering and Manufacturing Corp.
 - 2. Greenheck Corp.
 - 3. Loren Cook Company
 - 4. PennBarry

- B. Fan shall be a spun aluminum, roof mounted, belt driven, and downblast centrifugal ventilator.
- C. Fan shall be constructed in accordance with UL 705. Fan shall bear the AMCA certified ratings seal for air performance.
- D. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have sealed curb cap corners by continuous weld or application of butyl tape to inside of the curb cap for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.
- E. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.
- F. Motor: Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
- G. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- H. Belts & Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- I. Roof Curb: 12 inch high of 18 gauge galvanized steel construction with continuously welded seams, built-in cant strips, 1-1/2 inch insulation, damper tray, hinged curb adapter for access to dampers, and factory installed nailer strip. Coordinate installation with Division 7.
- J. Accessories:
 - 1. Motorized damper in damper tray of roof curb. Actuator shall be same voltage as motor in fan. Damper shall energize fan through integral end switch.
 - 2. Disconnect Switch: Coordinate with Division 26. Provide factory wired disconnect switch on 120v motor only. Factory provided disconnect switches shall be rated for outdoor use. Three phase combination disconnect/starter shall be provided by Division 26.
 - 3. Direct drive units shall be provided with motor speed control option.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 INSTALLATION

- A. Secure roof fans with cadmium plated steel lag screws to roof curb structure.
- B. Install power ventilators level and plumb.
- C. Install dampers in roof curb damper tray.
- D. Provide hinged curb adapter to permit access to dampers and duct connection.
- E. Install safety screen where inlet or outlet is exposed.
- F. Provide sheaves required for final air balance.
- G. Install units with clearances for service and maintenance.
- H. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 CLEANING

- A. Vacuum clean inside of fan cabinet.

3.4 DEMONSTRATION

- A. Demonstrate fan operation and maintenance procedures.

3.5 PROTECTION OF FINISHED WORK

- A. Do not operate fans until ductwork is clean, bearings are lubricated, and fan has been test run under observation.

END OF SECTION 23 34 00

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Air devices.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- C. Test Reports: Rating of air outlet and inlet performance.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Air Devices shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- D. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 AIR DEVICES

- A. Manufacturers:
 - 1. Krueger
 - 2. Titus
 - 3. Price
 - 4. Nailor
- B. Mounting:
 - 1. Plaster Surfaces: Provide with plaster frames or plaster rings to make air tight seal against mounting surface.
 - 2. "T" Bar Ceilings: Lay-in type.
 - 3. Gyp Board and Wall surfaces: 1-1/2" overlap flange.
- C. Fire rated diffusers for fire rated roof/ceiling assembly: Refer to diffuser schedule for fire rated assembly requirement.
 - 1. UL classified fire rated ceiling diffuser assembly listed in The Underwriters Laboratories "Fire Resistance Directory".
 - 2. Shall have a fire resistance rating of 3 hours.

3. Heavy Gauge Steel Diffusers shall be tested in accordance with UL 263 and must meet NFPA 90A requirements. Diffusers must be able to operate in (3) three hour fire rated ceiling and must be installed in accordance with the installation instructions.
 4. UL 555C Fire resistance rating: 3-hour ceiling radiation damper with fusible link assembly. Fire closure temperature of 165°F.
 5. UL listed thermal blanket insulation, mineral fiber around entire diffuser.
 6. Complete fire rated damper assembly with blanket shall be provided and submitted by/with Diffusers, Registers, and Grilles.
- D. Source Quality Control
1. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- E. Accessories:
1. Square to round neck adapter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify inlet and outlet locations.
- B. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Verify ceiling and wall systems are ready for installation.
- E. Refer to Architectural Code Information and Fire Rated Assemblies Drawing to verify if ceiling is fire rated. If ceiling is fire rated provide U.L. tested radiation damper with thermal blanket for all ceiling mounted supply and return air grilles.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00 – Air Duct Accessories.
- C. Install diffusers, registers, and grilles level and plumb.
- D. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure

drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- E. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- F. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 91 00.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.5 SCHEDULES:

- A. Refer to Drawings.

END OF SECTION 23 37 13

SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide complete, fully operational fans where indicated on Drawings.
- B. Section Includes:
 - 1. Roof mounted relief hood
- C. Related Sections:
 - 1. Section 23 31 00 - HVAC Duct and Casings: Product requirements for hangers for placement by this section.
 - 2. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 - 3. Coordinate work in this Section with Division 7.

1.2 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.4 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705 and UL 762 for kitchen exhaust.
- D. Balance Quality: Conform to AMCA 204.

- E. Energy Recovery Unit Wheel Energy Transfer Rating: Meet ARI 1060.

1.5 WARRANTY

- A. Furnish one (1) year manufacturer's warranty. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start date from shipment or start up will not be acceptable.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Ventilators shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- D. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS.

2.1 ROOF MOUNTED RELIEF HOOD

- A. Manufacturers:
 - 1. Acme Engineering and Manufacturing Corp.
 - 2. Greenheck Corp.
 - 3. Loren Cook Company
 - 4. Penn Ventilation
 - 5. Twin City
- B. Unit shall be an aluminum roof mounted relief hood.
- C. Construction: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The aluminum hood shall be constructed of minimum 14 gauge marine alloy aluminum, bolted to a minimum 8 gauge aluminum support structure. The aluminum base shall have sealed curb cap corners by continuous weld or application of butyl tape to inside of the curb cap for maximum leak protection. Bird screen constructed

of 1/2" mesh shall be mounted across the intake opening. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

- D. Roof Curb: 12 inch high of 18 gauge galvanized steel construction with continuously welded seams, built-in cant strips, 1-1/2 inch insulation, damper tray, hinged curb adapter for access to dampers, and factory installed nailer strip. Coordinate installation with Division 7.
- E. Accessories:
 - 1. Gravity actuated back-draft damper with adjustable counter weight.
 - 2. Motorized damper; actuator shall be low voltage for control wiring from DDC controllers. Damper shall include integral end switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 INSTALLATION

- A. Secure intake/relief hoods with cadmium plated steel lag screws to roof curb structure.
- B. Install dampers in roof curb damper tray.
- C. Provide hinged curb adapter to permit access to dampers and duct connection.
- D. Install safety screen where inlet or outlet is exposed.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Furnish services of factory trained representative for minimum of one (1) day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 CLEANING

- A. Vacuum clean inside of fan cabinet.

3.5 DEMONSTRATION

- A. Demonstrate fan operation and maintenance procedures.

3.6 PROTECTION OF FINISHED WORK

- A. Do not operate until ductwork is clean, bearings are lubricated, and fan has been test run under observation.

END OF SECTION 23 37 23

SECTION 23 74 13.19 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS WITH ENERGY RECOVERY WHEELS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 -GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes factory-packaged units capable of providing cooling and heating.
- B. Electrical characteristics: Coordinate with electrical plans prior to submitting equipment; provide single point power connections.

1.3 ACTION SUBMITTALS

- C. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- D. Provide line-by-line specification review annotated to certify compliance or deviation.
 - 1.
- E. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Prepare the following by or under the supervision of a qualified professional engineer:
 - a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - b. Include diagrams for power, signal, and control wiring.
- F. Delegated-Design Submittal: For design of vibration isolation, seismic restraints and wind restraints, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Unit fabrication and assembly details.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 3. Design Calculations:
 - a. Calculate requirements for selecting vibration isolators and seismic restraints and wind restraints and for designing vibration isolation bases.
 - b. Indicate compliance with "Performance Requirements" article.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
 - 2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.
- B. Seismic Qualification Certificates: For dedicated outdoor-air units, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Startup service reports.
- D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Spare materials shall be provided by equipment manufacturer and not by the installing mechanical contractor.
 - 1. Fan Belts: One (1) for each belt-driven fan.
 - 2. Filters: One (1) set for each unit.

1.7 WARRANTY

- A. Furnish one (1) year manufacturer parts and labor warranty for rooftop units. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start dates from shipment or start up will not be acceptable.
- B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
- C. All warranty work shall be performed by factory direct service technician. Warranty work shall not be performed by installing mechanical contractor.

1. Warranty Period for Compressors: (Five) 5 years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: (Five) 10 years from date of Substantial Completion.
3. All other parts and labor: (One) 1 year from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of units for period of one (1) years from Date of Substantial Completion.
- B. Include, on a quarterly basis, systematic examination, required adjustments, lubrication of unit and controls calibration. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use new parts produced by manufacturer of original equipment.
- C. Perform work without removing units from service during building normal occupied hours. Off-line work must be coordinated with Owner.
- D. At an additional cost to owner provide emergency call back service at all hours during this maintenance period.
- E. Maintain locally adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
- F. Perform maintenance work using authorized factory trained technicians.
- G. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.9 FACTORY TESTING

- A. All units shall be factory assembled, internally wired, fully charged with refrigerant, and 100% tested prior to leaving the factory. Certified factory testing report shall be sent to owner and engineer upon request. The factory test shall include a refrigerant circuit test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection. If unit fails any portion of the certified test, failures shall be corrected before unit leaves the factory.
- B. If for any reason unit does not meet the manufacturer's standards, those items shall be corrected and re-tested prior to leaving the factory with no additional cost to the owner.

PART 2 - PRODUCTS

2.1 ROOFTOP UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Aaon
 - 2. Trane
 - 3. Carrier
 - 4. York
- B. Configuration: Coordinate with project plans and schedules.
- C. Performance Base: Sea level pressure or altitude.
- D. Fabrication: Conform to AMCA 99 and ARI 430. Units shall be factory assembled and ship in one piece where possible. Shipping splits are acceptable provided manufacturer includes gaskets and bolts and performs final unit inspection.
- E. Unitary Air Conditioning Unit:
 - 1. CABINET
 - a. Construction: double wall.
 - b. Exterior Casing Material: 18 gauge galvanized steel with paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
 - c. Interior Casing Material: 18 gauge galvanized steel.
 - d. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360.
 - e. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width.
 - f. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
 - g. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
 - h. Base Rails: Full perimeter insulated galvanized rails for mounting on roof curb or pad as indicated. Provide lifting lugs on the top of unit to for rigging and handling.
 - i. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.

1. Service Doors: Hinged access doors with gaskets and quarter turn, zinc cast, lockable handles with full length stainless steel piano hinges. Material and construction of doors shall match material and construction of cabinet in which doors are installed and shall be thermally broken.
2. Roof: Standing seam or membrane; sloped to drain water. Include rain break overhangs above access doors.
- j. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- k. Cabinet Insulation:
 1. Type: Minimum 2 Lbs/cubic foot density engineered polymer foam injected insulation.
 2. Thickness: 2 inch
 3. Insulation Adhesive: Comply with ASTM C 916, Type I.
 4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
- l. Condensate Drain Pans:
 1. Cooling Coil Drain Pan: Double wall stainless steel IAQ pan with two (2) inch insulation and welded corners. Drain pans without welded corners are not acceptable. Cross break and pitch to drain connection. Cooling coils with a finned height greater than 48 inches shall have an intermediate stainless steel IAQ drain pan extending entire length of coil. Intermediate pan shall have a minimum of two drop tubes to main pan. Drain pans shall allow no standing water and comply with ASHRAE Standard 62. Drain pans must be accessible for cleaning.
- m. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.
- n. Roof Curb: Roof Curb shall be designed to mate with the down flow supply and return openings and provide support and a watertight seal. The roof curb design shall allow field-fabricated rectangular supply/return ductwork to be connected directly to the curb. Curb design shall comply with NRCA requirements. Curbs shall be shipped knocked down for tool less field assembly and include wood nailer strips.

1. Comply with requirements in "The NRCA Roofing Manual."
2. Match roof curb to roof slope to provide level surface for AHU mounting.
3. Provide curb having vertical members insulated with a minimum thermal resistance (R-value) of 6.0 BTU/hr-ft²-°F or greater.
4. Curb height: 12 inches minimum.
5. Provide curb with continuous insulation between unit base and roof curb.
6. Roof Curb for Horizontal Airflow - Horizontal openings in curb shall be custom designed for return and/or discharge for horizontal air handling. Opening size and location shall be indicated on drawings and/or schedule.
7. Provide wood nailing strip to which roofer may nail roof flashing.
8. Ship roof curb loose for field installation prior to unit placement.

2. SUPPLY FAN

- A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced (Refer to schedule for fan type).
 1. Fan Wheel Material: Galvanized steel, mounted on solid-steel shaft.
 2. Bearings: Self-aligning permanently lubricated ball bearings.
- B. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades (Refer to schedule for fan type).
 1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
 2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
 3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
 4. Fan Enclosure: Easily removable enclosure around rotating parts.
 5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.
- C. Supply fans shall be provided with a (VFD) variable frequency drive for balancing and soft start purposes. VFD shall be factory provided and installed and wired in a ventilated controls compartment by manufacturer prior to shipment. Externally mounted VFD's shall be provided in NEMA 3R enclosure. VFD's shall be provided with a bypass. Refer to section 23 05 14 'Variable Frequency Drives' for requirements and list of acceptable manufacturers.

- D. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.
- E. Motors:
 - 1. Motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - 3. Efficiency: Premium, inverter rated.
 - 4. Enclosure: Totally enclosed fan cooled (TEFC).
 - 5. Electronically Commutated Motors (ECM).
- F. Mounting: Locate fan and motor internally on welded or bolted steel base coated with corrosion resistant paint or rust-resistant G90 steel and factory-mounted motor on slide rails. Furnish access to motor, drive, and bearings through hinged access doors. Fan wheel and motor shall be dynamically balanced after assembly and mounted on a fan isolation sled with rubber in shear isolators. Refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment or 2" deflection, whichever requirement is stricter.

3. COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: 304 Stainless Steel.
- C. Tube Material: Copper.
- D. Tube Header Material: Copper.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Capacity Reduction: Circuit coils for intertwined control.
- I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- J. Coating: Coils shall have a post-construction, flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM

D870-92). Corrosion durability shall be confirmed through testing to no less than 6,000 hours salt spray per ASTM B117-90. Coated coils shall receive a spray-applied, UV-resistant polyurethane topcoat to prevent UV degradation of the e-coat. Coating shall carry a 5 year warranty, from the date of substantial completion.

4. REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and over temperature protection, internal pressure relief and crankcase heater.
- D. Refrigerant: R-410A.

- 3. Classified as Safety Group A1 according to ASHRAE 34.
- 4. Provide unit with operating charge of refrigerant.

E. Refrigeration System Specialties:

- 1. Expansion valve with replaceable thermostatic element.
- 2. Refrigerant dryer.
- 3. High-pressure switch.
- 4. Low-pressure switch.
- 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
- 6. Brass service valves installed in discharge and liquid lines.

F. Capacity Control:

- 1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
- 2. Rawal APR control with zero to 100 percent modulating capacity control using hot-gas bypass. Evaporator coil shall be continuously active for dehumidification.
- 3. Variable speed compressors.

G. Refrigerant condenser and reheat condenser coils:

- 1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- 2. Tube Material: Copper.
- 3. Fin Material: Aluminum.

4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.
6. Coating: Factory fully dipped aluminum fins mechanically bonded to seamless copper tubing. Fully dipped coils shall be of the Black- fin baked epoxy type with UV top coat. Furnish sub-cooling circuits as applicable.
7. All units require louvered panels for added protection of the condenser coils from hail and other physical damage.

H. Condenser Fan Assembly:

1. Condenser Fan: Low sound operating, PVC coated fan guard, direct drive propeller type fans to discharge vertically. FRP construction on condenser fans under 15-tons. Fully dipped and baked epoxy on condenser fan assembly is also acceptable.
2. Condenser Fan Motor: Totally enclosed air over (TEAO), permanently lubricated, permanently lubricated ball bearings; resiliently mounted; overload protected. Motors shall be ECM, Electronically Commutated Motors, on all units.
3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

5. INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
3. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners:

1. Heat-Exchanger Material: Stainless steel with a minimum thermal efficiency of 80 percent.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan Material: Stainless steel.

D. Retain one of two "Venting" paragraphs below.

- E. Venting: Gravity vented.
- F. Safety Controls:
 - 1. Gas Control Valve: Electronic modulating.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

6. ENERGY RECOVERY WHEEL

- A. Acceptable manufacturers: NovelAire, AlRotor, SEMCO
- B. Casing construction shall be the same as the rest of the unit.
- C. Total energy recovery wheel shall be installed by air unit manufacturer at the factory prior to shipment. Shall be an integral component of the fully assembled unit.
- D. Energy recovery wheel shall be constructed of corrugated media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated bonded, or synthesized onto the media are not acceptable due to delaminating or erosion of the desiccant material
- E. Media shall be resistant to corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage.
- F. Rotor shall be constructed of alternating layers of flat and corrugated media.
- G. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of channeling and performance degradation.
- H. The minimum acceptable performance shall be as specified in the unit schedule
- I. Desiccant Material: The desiccant material shall be a molecular sieve, and specifically a 4A or 3A molecular sieve to minimize cross contamination.
- J. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment.
- K. Wheel Seals: The wheel seals shall be full contact nylon brush seals or equivalent. Seals should be easily adjustable.

- L. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air as shown on unit schedule.
- M. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings.
- N. Drive systems shall consist of fractional horsepower AC drive motors with multi-link drive belts.
- O. Face and bypass dampers shall be furnished as shown on unit schedule and drawings.
- P. The wheel shall be listed or recognized by UL or equivalent.

7. OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood painted to match exterior unit.
- B. Materials: Match cabinet.
- C. Motorized Outside Air Dampers – Field-installed manually set outdoor air dampers with actuator shall provide up to 100 percent outside air (refer to schedule). Once set, outdoor air dampers shall open to set position when indoor fan starts. The damper shall close to the full closed position when indoor fan shuts down.
- D. Bird Screen: Provide 1 inch aluminum mesh pre filter upstream of the outside air opening.
- E. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

8. FILTERS

- A. The filter rack shall be designed to handle a maximum 2" thick pre-filter and maximum 2" thick final filter. Filters replaceable through side access, hinged access door.
- B. Replaceable Filter Media: MERV 13 or greater rating in accordance with ASHRAE Test Standard 52.2.
- C. High Capacity Filter: Two (2) inch extended area filters. Air quantities as scheduled, clean pressure drop of 0.10 inches wg; dirty pressure drop of 0.75 inches wg.
- D. Provide factory mounted Dwyer 2002 series magnehelic gauge and dirty filter switch for integration to BAS.
- E. Filter Area: Max velocity of 350 FPM.
- F. Acceptable manufacturer: American Air Filter

9. ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 4X, mounted in unit with hinged access door in unit cabinet having a lock and key.
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to [wire lugs] [NEMA KS 1, heavy-duty, non-fused disconnect switch].
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - 2. NEMA KS 1, heavy-duty, non-fusible switch.
 - 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights. Unit shall include factory wired control panel compartment LED service lights.
- K. Control Relays: Auxiliary and adjustable time-delay relays.
- L. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

10. CONTROLS

- A. BAS Interface: Completely integrated microprocessor based Direct Digital Control (DDC) system to control all functions including space temperature, leaving air temperature, space humidity, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times and diagnostics. The system shall be provided with all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All microprocessor boards, hardware and software shall be factory provided and installed to enable the BAS to monitor, control, and display unit status and alarms.

- B. Unit shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Units shall provide an external location for mounting a fused disconnect device. 24-volt electromechanical control circuit shall include control transformer and contactor pressure lugs for power wiring. Unit shall have single point power entry as standard.
- C. ASHRAE 135 BACnet communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.
- D. Hardwired Points:
 - 1. Monitoring: On-off status, (common trouble alarm).
 - 2. Control: On-off operation, space temperature set-point adjustment, supply temperature set-point adjustment, space humidity set-point adjustment, space pressure set-point adjustment.

11. REQUIRED ACCESSORIES

- A. Convenience Outlet: A GFCI, 120v/15amp, 2 plug, and convenience outlet, unpowered. The convenience outlet is powered from the line side of the disconnect or circuit breaker.
- B. Dehumidification System (Hot-gas reheat):
 - 1. Shall be provided as a factory installed option. Hot gas reheat coil shall include modulating components and controls. On/off control or staged control is not acceptable.
 - 2. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
 - 3. Evaporator temperature to be precisely controlled by monitoring the compressor saturated suction temperature.
 - 4. Shall be capable of activating the cooling system along with the hot-gas reheat coil when the sensed humidity level exceeds the desired set point.
 - 5. Shall be capable of simultaneously operating both the non hot-gas reheat compressor circuits and hot-gas reheat compressor circuits of multiple compressor units when both the humidity level and the first stage cooling temperature level exceed their set points.
 - 6. Shall be capable of prioritizing a cooling demand over a dehumidification demand and shut off the hot-gas reheat coil circuit(s) to meet the temperature requirements. Shall be able of turning the hot-gas reheat coil back on if the dehumidification demand still exists after the cooling demand has been met.

7. Shall consist of a reheat coil, three-way solenoid valve, a check valve and associated copper piping.
8. Reheat coil shall be constructed with enhanced aluminum fins mechanically bonded to copper tubes. Fin count shall not exceed 14 fins per inch.
9. Reheat coil shall be located on the leaving air side of the evaporator coil.
10. Three way solenoid valves shall be non-modulating type and normally closed for the reheat coil.
11. Check valve shall be provided to prevent reverse flow of refrigerant during cooling operation.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations.
 3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.
- C. Equipment Mounting (Where Applicable): Install floor or on-grade mounted units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases as specified

1. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install on 6-inch high concrete base designed to withstand, without damage to equipment, seismic force required by code.
- D. Suspended Units (Where Applicable): Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- E. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- G. Unless shown to come through roof curb to internal drain install drain pipes from unit drain pans to approved roof drain.
1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L (ASTM B 88M, Type B), with soldered joints.
 5. Pipe Size: Same size as condensate drain pan connection.
 6. Insulate condensate piping according to section 23 07 19 HVAC Piping Insulation.
 2. Provide rooftop portable pipe supports in 6'-0" maximum intervals. Roof supports shall be manufactured by Advanced Support Products (ASP), model REC-SA (Rubber EcoCurb) with channel or approved equal. Product specifications:
 1. Bases: 100% recycled Vulcanized Rubber with UV inhibitors.
 2. Weight: Base with assembly 9.5 pounds
 3. Dimensions: 9" x 6" x 4"
 4. Height: Adjustable
 5. Hot dipped galvanized threaded rods, nuts and washers

3.3 CONNECTIONS

- A. Coordinate installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems.
- B. Where installing piping adjacent to units, allow space for service and maintenance.

C. Gas Piping Connections:

1. Comply with requirements in Section 23 11 23 "Natural-Gas Piping."
2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
3. Install AGA-approved flexible connectors.

D. Duct Connections:

1. Comply with requirements in Section 23 31 13 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 23 33 00 "Air Duct Accessories."

E. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

A. A factory-authorized service representative shall perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.

- c. Condenser coil entering-air dry-bulb temperature.
- d. Condenser coil leaving-air dry-bulb temperature.

7. Simulate maximum cooling demand and inspect the following:

- a. Compressor refrigerant suction and hot-gas pressures.
- b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 - 1. Inspect casing insulation for integrity, moisture content, and adhesion.
 - 2. Verify that clearances have been provided for servicing.
 - 3. Verify that controls are connected and operable.
 - 4. Verify that filters are installed.
 - 5. Clean coils and inspect for construction debris.
 - 6. Clean furnace flue and inspect for construction debris.
 - 7. Inspect operation of power vents.
 - 8. Purge gas line.
 - 9. Inspect and adjust vibration isolators and seismic restraints.
 - 10. Verify bearing lubrication.
 - 11. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 12. Adjust fan belts to proper alignment and tension.
 - 13. Start unit.
 - 14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
 - 15. Operate unit for run-in period.
 - 16. Calibrate controls.
 - 17. Adjust and inspect high-temperature limits.
 - 18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
 - 19. Verify operational sequence of controls.
 - 20. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air flow.
 - c. Outdoor-air flow.
- A. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- B. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- C. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

- A. A factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain units.

3.7 COMPLETION AND CLEANUP

- A. Contractor shall comb and vacuum clean coils, inside and outside of unit cabinet prior to start-up.
- B. Install temporary filters during construction and start-up period. Replace with specified filters at Substantial Completion.

3.8 PROTECTION OF FINISHED WORK

- A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation

END OF SECTION 23 74 13.19

SECTION 23 81 26 - DUCTLESS MINI-SPLIT-SYSTEM AIR-CONDITIONERS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART I -GENERAL

1.1 RELATED DOCUMENTS

- A. Section 23 05 00 – Common Work Results for HVAC.

1.2 GENERAL REQUIREMENTS

- A. Indoor, wall or ceiling mounted, direct-expansion fan coils are matched with cooling only outdoor unit.
- B. Outdoor air-cooled split system compressor sections suitable for on-the-ground, rooftop, wall hung or balcony mounting. Units shall consist of a rotary compressor, an air-cooled coil, propeller-type draw-through outdoor fan, metering device(s), and control box. Units shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to-air cooling only or heat pump system (refer to schedule).
- C. Indoor unit shall be rated per ARI Standards 210/240 and listed in the ARI directory as a matched system.
- D. A factory provided and installed BACnet communication interface card with building automation system shall enable building automation system operator to remotely control and monitor the system from an operator workstation. Control features available, and monitoring points displayed, locally at fan coil controller shall be available through building automation system.
- E. Outdoor unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with the NEC. Units shall be evaluated in accordance with UL standard 1995. Units shall be listed in the CEC directory. Unit cabinet shall be capable of withstanding 500-hour salt spray test per Federal Test Standard No. 141 (method 6061). Air-cooled condenser coils shall be leak tested at 573 psig.
- F. Provide equipment with electrical characteristics as shown on the Electrical Drawings.

1.3 ACCEPTABLE MANUFACTURERS

- A. LG – LS Series
- B. Trane
- C. Mitsubishi – P Series

1.4 SUBMITTAL:

- A. Submit in form similar to the schedule on the Drawings. Show all data listed in schedule, electrical characteristics and accessories being provided.
- B. Provide line-by-line specification review annotated to certify compliance or deviation.

- C. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures.
- D. Product Data: Submit product data, including manufacturer's □product sheet for specified products.

1.5 WARRANTY

- A. One (1) year on unit parts other than compressor/motor assembly. Warranty shall begin from date of Certificate of Substantial Completion.
- B. Five (5) years on compressor/motor assembly. Warranty shall begin from date of Certificate of Substantial Completion.
- C. One (1) year on refrigerant and oil. Warranty shall begin from date of Certificate of Substantial Completion.

PART 2 –PRODUCTS

2.1 UNIT CABINET:

- A. Indoor unit cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
- B. Outdoor unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish on inside and outside. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
- C. Indoor and outdoor unit shall be of the same manufacturer.

2.2 COMPRESSOR

- A. Compressor shall be fully hermetic rotary type. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere. Compressor assembly shall be installed on rubber vibration isolators.

2.3 COIL

- A. Evaporator coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.
- B. Condenser coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.

2.4 FANS

- A. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.

2.5 AIR FILTERS

- A. Unit shall have filter track with factory-supplied cleanable filters.

2.6 BUILDING AUTOMATION SYSTEM INTERFACE:

- A. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 62° F to 84°F.
- B. The unit shall have integral controls provided by unit manufacturer to perform input functions necessary to operate the system. Factory installed hardware and software to enable building automation system to monitor, control, and display status and alarms.
 - 1. A factory provided and installed BACnet communication interface card with building automation system shall enable building automation system operator to remotely control and monitor the system from an operator workstation. Control features available, and monitoring points displayed, locally at fan coil controller shall be available through building automation system.
 - 2. The unit shall be compatible with interfacing with connection to BACnet networks or interfacing with connection to BMS system.
- C. The unit shall have the following functions as a minimum:
 - 1. An automatic restart after power failure at the same operating conditions as at failure.
 - 2. A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
 - 3. Temperature-sensing controls shall sense return air temperature.
 - 4. Indoor coil freeze protection.
 - 5. Wireless infrared remote control to enter set points and operating conditions.
 - 6. Automatic air sweep control to provide on or off activation of air sweep louvers.
 - 7. Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
 - 8. Fan-only operation to provide room air circulation when no cooling is required.
 - 9. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.

DUCTLESS MINI-SPLIT-SYSTEM AIR-CONDITIONERS

10. Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
11. Automatic heating-to-cooling changeover in heat pump mode. Control shall include dead band to prevent rapid mode cycling between heating and cooling.
12. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

PART 3 -EXECUTION

3.1 FIELD QUALITY CONTROL

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 1. Leak Test: After installation, fill water coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
 2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

3.2 STARTUP SERVICE

- A. Refer to Section 23 05 93 Testing, Adjusting, and Balancing for HVAC.

3.3 CLEANING

- A. Clean units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- B. After completing system installation and testing, adjusting, and balancing fan coil and air-distribution systems clean filter housings and install new filters.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 23 81 26

SECTION 23 82 39.19 - ELECTRIC UNIT HEATERS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electric Unit Heaters.
- B. Related Sections:
 - 1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers for placement by this section.
 - 2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.

1.3 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
 - 2. ASHRAE 103 - Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.
- B. Underwriters Laboratories Inc.:
 - 1. Units to be UL Listed.

1.4 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.

2. Location and size of each field connection.
3. Details of anchorages and attachments to structure and to supported equipment.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of integral controls.
6. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Suspended ceiling components.
 2. Structural members to which unit heaters will be attached.
 3. Method of attaching hangers to building structure.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Access panels.
 6. Lighting fixtures.
 7. Perimeter moldings for exposed or partially exposed cabinets.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept heaters and controls on site in factory packaging. Inspect for damage.

1.9 WARRANTY

- A. Furnish five (5) year manufacturer warranty for heat exchanger.

PART 2 - PRODUCTS

2.1 ELECTRIC UNIT HEATERS

- A. Manufacturers:
 - 1. Chromalox
 - 2. Reznor
 - 3. Trane
 - 4. Brasch
 - 5. Markel
- B. Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, controls, and accessories complying with ARI 440:
 - 1. Discharge Louvers: Individually adjustable horizontal and vertical louvers to match cabinet finish.
 - 2. Control Voltage: 24 volt, 60 hertz
 - 3. Wall mounted adjustable thermostat.
 - 4. Location: Suspended overhead.
 - 5. Comply with UL 2021.
- C. Cabinet: 18 gauge steel with baked enamel finish, easily removed and secured access panels, insulated or double panel construction.
- D. Supply Fan: Propeller type with direct drive, dynamically balanced and mounted with rubber vibration insulators.
- E. Heat Exchanger: High mass, all steel tubular finned type, copper brazed elements.
- F. Controls: Wall mounted Thermostat with fan switch.
- G. Motor: Totally enclosed industrial rated. Motor on units to 20KW shall utilize sealed bearings. Motor on units larger than 20KW shall be 2-speed, permanent capacitor-type, continuous duty.
- H. Wiring:
 - 1. Sub-divided circuits with individual fuse protection
 - 2. Internal 24V control transformer.
 - 3. Heavy duty magnetic contactors.

4. Thermal cutouts on control circuit with automatic reset.
5. Low voltage thermostatic kit with fan switch.
6. Factory wired disconnect switch.
7. Performance: Provide equipment as scheduled on Drawings.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinet unit heaters to comply with NFPA 90A.
- B. Install unit heaters level and plumb.
- C. Suspend cabinet unit heaters from structure with elastomeric hangers. Refer to Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with owner, architect, and engineers prior to installation.
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Comply with safety requirements in UL 1995.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 23 82 39.19

SECTION 26 01 05 - COMMISSIONING OF ELECTRICAL SYSTEMS BY Cx PROFESSIONAL

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract Documents, including General and Supplementary Conditions and Division 01 Specifications, apply to this section.
- B. Related Requirements
 - 1. 23 01 04 Preparation for HVAC Cx by Contractor
 - 2. 23 01 05 Commissioning of HVAC by Cx Professional
 - 3. 26 05 00 Common work results for Electrical.
 - 4. 26 01 06 Preparation for Commissioning of Electrical Systems by Contractor
 - 5. 26 09 23 Digital Lighting Control System
- C. Reference Standards
 - 1. 2015 IECC
 - 2. 2017 NEC

1.2 SUMMARY:

- A. The commissioning of the lighting system and associated controls shall be performed by an impartial technical firm hired by the Owner. The commissioning provider shall be certified under one or more of the following certifications:
 - 1. CxA – Certified Commissioning Authority – AABC Commissioning Group
 - 2. CBCP – Certified Building Commissioning Professional – Association of Energy Engineers.
 - 3. CCP – Certified Commissioning Professional – Building Commissioning Association.
 - 4. CPMP – Certified Process Management Professional – ASHRAE
 - 5. BSC – Building System Commissioning Certification – National Environmental Balancing Bureau.
- B. The commissioning provider (Commissioning Agent) shall be responsible for leading the entire construction team through the commissioning process including, but not limited to, conducting the commissioning kick-off meeting, preparing the commissioning plan, preparing pre-functional checklists, preparing functional test scripts, participation in functional testing and preparation of required documentation and reports.

1.3 RESPONSIBILITIES:

- A. The Commissioning Agent shall provide a letter certifying the installed lighting controls meet documented performance criteria specified in the commissioning plan within 90 days of substantial completion.

1.4 COMMISSIONING PLAN:

- A. Commissioning Process tasks and activities:
 - 1. Commissioning kick-off meeting: Conducted by Commissioning Agent and attended by construction team and design team.

2. Pre-functional checklists: Prepared by the Commissioning Agent and filled out by subcontractors performing the work that is applicable.
 3. Site visits to review installation of applicable systems and progress of checklist documentation performed and reported by Commissioning Agent.
 4. Functional testing: Commissioning Agent shall conduct functional testing with assistance of applicable subcontractors and document successful results as well as deficiencies (issues). Functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing in accordance with plans and specifications.
 5. Preliminary commissioning report: Commissioning Agent shall issue a preliminary commissioning report to the Owner that has results of the first round of functional testing including deficiencies discovered.
 6. Systems manual: Commissioning Agent shall compile the systems manual using submittal data provided by the general contractor and applicable subcontractors.
 7. Final commissioning report: Commissioning Agent shall issue final commissioning report documenting the entire process and final results of functional testing. Refer part "4 Documentation" within this document section for additional requirements.
- B. Electrical System Equipment to be tested:
1. Energy Management System Controls as it relates to lighting controls only.
 2. Daylighting controls
 3. Time switches
 4. Occupancy sensors
 5. Emergency Lighting
 6. Architectural Dimming Systems (when applicable)
 7. Demand Response Controls (when applicable)
 8. Exterior Lighting
 9. Inverters/ Central Battery Systems (when applicable)
 10. Generators (when applicable)
- C. Testing functions and conditions:
1. Energy Management System Controls
 - a. The Electrical Commissioning Agent shall work directly with the HVAC Commissioning Agent to coordinate the functional testing of every piece of electrical equipment through the controls front end. Examine every graphic page to outline any deficiencies or items needing correction and provide a detailed summary report of any findings.
 2. Daylighting control devices:
 - a. Verify the devices have been calibrated, properly located and adjusted.
 - b. Loads adjust to light level set points in response to daylight.
 - c. Location of calibration equipment is accessible to authorized personnel only.
 3. Time switches:
 - a. Verify schedule, time, date and programming is accurate. This shall include weekday, weekend and holiday schedules.
 - b. Verify override time limit is set, battery is installed and switch operates the lights that are specified in the design documents. Verify override time limit is no greater than 2 hours.
 - c. All specified lights can be turned on and off by area control switch.
 - d. Manual override switch allows only the lights in the space where the switch is located turn on or remain on until next scheduled shut off.
 - e. Verify battery backup is installed and energized.
 - f. Simulate both occupied and unoccupied conditions, verifying the specified control sequence.

4. Occupancy sensors:
 - a. Certify the sensor has been located and aimed in accordance with manufacturer recommendations.
 - b. For projects with fewer than seven sensors, each sensor shall be tested.
 - c. For projects with more than seven occupant sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each combination are provided not less than 10 percent shall be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested. The General Contractor shall be responsible (not the Owner) to compensate the Commissioning Agent for the additional time/services required to verify the occupant sensor controls to comply with section C408.3.1.1.3 of the 2015 **2015** IECC.
 - d. Verify correct operation of status indicators.
 - e. Controlled lights turn off or down to the permitted level with in the required time.
 - f. For auto-on sensor, the lights turn-on to the permitted level when an occupant enters space.
 - g. Verify the lights are not incorrectly turned-on by movement in adjacent areas or by HVAC operation.
 - h. For occupancy sensors that have auxiliary contacts for HVAC controls, confirm operation and function with the HVAC Commissioning Agent and the DDC Vendor.
5. Emergency Lighting:
 - a. Certify that all emergency exit signs are energized and are visible, with no obstructions blocking their view for personnel within the building.
 - b. Ensure that all emergency lighting fixtures are energized upon a loss of power. This shall include both interior and exterior lighting.
6. Architectural Dimming Systems:
 - a. Interior lighting shall be tested to ensure the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the contract documents and the vendors installation instructions. This shall include ON/OFF controls, Dimming Controls and Pre-Selected lighting levels. Specific attention shall be given to the coordination with the Occupancy Sensors and Daylighting Control Devices.
 - b. Ensure all 'Night Lighting' systems are functional and working.
7. Demand Response Controls:
 - a. Confirm integration with the Energy Management System is functional and working.
 - b. Witness a manual test of the system and confirm the appropriate lighting (load) is de-energized when the demand response is called for.
8. Exterior Lighting:
 - a. Exterior lighting shall be tested to ensure the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the contract documents and the vendors installation instructions. This shall include ON/OFF controls, Dimming Controls and Pre-Selected lighting levels. Specific attention shall be given to the coordination with the TIME CLOCK and the Energy Management System Controls.

9. Inverters:
 - a. Verify startup has been performed and that the operation of the unit is functional for the purpose of which it has been programmed.
 - b. Witness a manual test of the system and confirm the appropriate lighting (load) engages when the system is operational.
 - c. Confirm integration with the Energy Management System is functional and working.
 - d. Confirm the Owner has been trained on the operation and maintenance of the system.
10. Performance criteria:
 - a. Daylighting controls shall maintain specified light levels within 5% of design.
 - b. All time switches shall be accurate to time on cellular network devices.

PART 2 – PRODUCTS

2.1 NO PRODUCTS SUPPLIED

PART 3 – EXECUTION

3.1 GENERAL

- A. Commissioning Agent will conduct site inspections at critical times and issue Cx Field Reports with observations on installation deficiencies so that they may be issued by Architect as deemed appropriate.

3.2 FUNCTIONAL PERFORMANCE TESTING (FPT)

- A. Contractor, in cooperation with Commissioning Agent, shall conduct Functional Performance Testing to validate compliance with Contract Documents.
- B. Refer to commissioning plan for detailed list of equipment to be commissioned.

3.3 RE-TESTING AND FAILURE TO REMEDY DEFICIENCIES:

- A. At his discretion, CxA may agree to re-testing systems or equipment where deficiencies remain which are beyond the Contractor's control to resolve expeditiously.
- B. Typically such re-testing of incomplete systems and equipment will take place only if remaining deficiencies are minor in scope and nature, and are of such nature that they cannot be resolved in a timely manner (such as those due to difficulties in obtaining parts, or where the Owner has requested a change that has delayed work) CxA will carry out a second re-inspection or re-test of systems and equipment subsequent to receiving Contractor's request.
- C. If CxA finds non-conforming work, deficiencies during an initial inspection or test have not been remedied (with exception of un-resolvable deficiencies in 3.b. above), and such remaining deficiencies are significant enough to require additional inspection or re-testing, Contractor will be back-charged for CxA's expenses, and time at a rate of \$150 per hour, for a third and any subsequent re-inspections and re-tests. The Contractor will also be

responsible for paying reasonable cost of travel expenses of the following representatives who were physically present for the purpose of witnessing the start-up or the Functional Performance Tests: the CxA, Architect & Engineering team and the Owner. The Owner is entitled to reimbursement or payment from the Contractor under or pursuant to the Contract Documents. If the Contractor fails to promptly make any payment due to the Owner, then the Owner shall have an absolute right to offset such amount against the Contract Sum.

- D. For projects with more than seven occupant sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each combination are provided not less than 10 percent shall be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested. The General Contractor shall be responsible (not the Owner) to compensate the Commissioning Agent for the additional time/services required to verify the occupant sensor controls to comply with **section C408.3.1.1.3 of the 2015 IECC**.

3.4 DOCUMENTATION:

Commissioning Agent shall provide documentation as follows:

1. Preliminary commissioning report including test procedures, results of testing, itemization of deficiencies, deferred tests and climatic conditions required for performance of deferred tests. Preliminary commissioning report shall be issued to [CoSA] and the Owner to demonstrate the first pass of testing has occurred and to demonstrate compliance with applicable codes.
2. The Commissioning Agent is responsible for preparing and submitting the final commissioning report to the Owner and the design team.
3. The report includes all system verification and start-up checklists, and all functional performance test checklists, completed with all test observations, problems encountered, corrective actions taken, and re-test results, dated and signed by those carrying out and witnessing the tests.
4. Where checklists make reference to other test reports, copies of those reports must be appended.
5. The Commissioning Report shall include the following:
 - a. The final commissioning report shall contain an executive summary addressing design intent conformance for all commissioned equipment and systems. The report shall include the results of the commissioning program, including observations, conclusions, and any outstanding issues.
 - b. History of any system deficiencies identified and how they were resolved, including any outstanding issues.
 - c. Systems performance test results and evaluation.
 - d. Confirmation from the Commissioning Agent indicating whether individual systems meet the Owner's Project Requirements, design narrative and contract documents.

The Owner shall receive the final commissioning report within 90 days of the date of receipt of the Certificate of Occupancy. The Owner and the design team shall meet to review the final commissioning report along with the Commissioning Agent.

The final report shall be delivered in format that is acceptable to the Owner. Submit a sample report to the Owner no later than 45 days prior the Certificate of Occupancy. The final report will be submitted in triplicate (3) hardcopies in hard-bound 3-ring binder with index and tabbed dividers and one (1) electronic PDF file on a flash drive. The final document shall be affixed with the Commissioning Agent certification/license seal and signature.

END OF SECTION 26 01 05

SECTION 26 01 06 - PREPARATION FOR COMMISSIONING OF ELECTRICAL SYSTEMS BY CONTRACTOR

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract Documents, including General and Supplementary Conditions and Division 01 Specifications, apply to this section.
- B. Related Requirements
 - 1. 23 01 04 Preparation for HVAC Cx by Contractor.
 - 2. 23 01 05 Commissioning of HVAC by Cx Professional.
 - 3. 26 05 00 Common work results for Electrical.
 - 4. 26 01 05 Commissioning of Electrical Systems by Cx Professional.
- C. Reference Standards
 - 1. 2015 **IECC**
 - 2. 2017 NEC

1.2 RESPONSIBILITIES:

- A. General Contractor:
 - 1. Facilitate coordination of Commissioning work by Commissioning Agent.
 - 2. Attend Commissioning meetings or other meetings called by Commissioning Agent to facilitate the Commissioning Process.
 - 3. Review Functional Performance Test procedures for feasibility, safety, and impact on warranty, and provide Commissioning Agent with written comment on same.
 - 4. Provide all documentation relating to manufacturer's recommended performance testing of equipment and systems.
 - 5. Provide Operations & Maintenance data to Commissioning Agent for preparation of checklists and training manuals.
 - 6. Provide As-built drawings and documentation to facilitate Testing.
 - 7. Assure and facilitate participation and cooperation of Sub Contractors and equipment suppliers as required for the Commissioning Process.
 - 8. Certify to Commissioning Agent that installation work listed in Pre-Functional Checklists has been completed.
 - 9. Install systems and equipment in strict conformance with project specifications, manufacturer's recommended installation procedures, and Pre-Functional Checklists.
 - 10. Provide data concerning performance, installation, and start-up of systems.
 - 11. Provide copy of manufacturers filled-out start-up forms for equipment and systems.
 - 12. Ensure systems have been started and fully checked for proper operation prior to arranging for Testing with Commissioning Agent. Prepare and submit to Commissioning Agent written certification that each piece of equipment and/or system has been started according to manufacturer's recommended procedure, and that system has been tested for compliance with operational requirements. Contractor shall carry out manufacturer's recommended start-up and testing procedures, regardless of whether or not they are specifically listed in Pre-Functional Checklists. Contractor is not relieved of obligation for systems/equipment demonstration where performance testing is required by specifications, but a Functional Performance Test is not specifically designated by Commissioning Agent.
 - 13. Coordinate with Commissioning Agent to determine mutually acceptable date of Functional Performance Tests.

14. Provide qualified personnel to assist and participate in Commissioning.
 15. Provide test instruments and communications devices, as prescribed by Commissioning Agent, required for carrying out Testing of systems.
 16. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment.
 17. The Contractor shall provide the test equipment, demonstrate its use, and assist in the commissioning process. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.
 18. Ensure deficiencies found in the Commissioning Issues Log are corrected within the time schedule shown in the Commissioning Plan.
 19. Provide Commissioning Agent with all submittals, start-up instructions manuals, operating parameters, and other pertinent information related to Commissioning Process. This information shall be routed through Architect.
 20. Prepare and submit to Commissioning Agent proposed Training Program outline for each system.
 21. Coordinate and provide training of Owner's personnel.
 22. Prepare Operation & Maintenance Manuals and As-Built drawings in accordance with specifications.
 23. Commissioning requires participation of this Division Subcontractors to ensure that systems are operating in manner consistent with Contract Documents. All costs associated with the participation of Contractor, Sub-Contractors, Design Professionals, and Equipment Vendors in the Commissioning Process shall be included as part of the Construction Contract.
- B. Subcontractors and vendors shall prepare and submit to Commissioning Agent proposed Startup procedures to demonstrate proper installation of systems, according to these specifications and checklists prepared by Commissioning Agent.

1.3 COMMISSIONING PLAN:

- A. Electrical System Equipment to be tested:
1. Energy Management System Controls as it relates to lighting controls only.
 2. Daylighting controls
 3. Time switches
 4. Occupancy sensors
 5. Emergency Lighting
 6. Architectural Dimming Systems (when applicable)
 7. Demand Response Controls (when applicable)
 8. Exterior Lighting
 9. Inverters/ Central Battery Systems (when applicable)
 10. Generators (when applicable)

PART 2 – EXECUTION

2.1 GENERAL

- A. Coordinate with other Sub-Contractors and equipment vendors to set aside adequate time to address Pre-Functional Checklists, Functional Performance Tests, Operations & Maintenance Manual creation, Owner Training, and associated coordination meetings.

2.2 WORK PRIOR TO COMMISSIONING:

- A. Complete all phases of the work so the systems can be started, adjusted, balanced and otherwise tested.
- B. See pertinent specification sections in this Division, which outline responsibilities for start-up of equipment with obligations to complete systems, including all subsystems so that they are fully functional.
- C. Assist Commissioning Agent with all information pertaining to actual equipment and installation as required complete the full commissioning scope.
- D. Contractor shall prepare startup procedures to demonstrate compliance with pre-functional checklists, and coordinate scheduling for completion of these checklists.
- E. A minimum of 7 days prior to date of system startup, submit to Commissioning Agent for review, detailed description of equipment start-up procedures which contractor proposes to perform to demonstrate conformance of systems to specifications and Checklists.

2.3 PARTICIPATION IN COMMISSIONING:

- A. Attend meetings related to the Commissioning Process; arrange for attendance by personnel and vendors directly involved in the project, prior to testing of their systems.
- B. Provide skilled technicians to startup and test all systems, and place systems in complete and fully functioning service in accordance with Contract Documents.
- C. Provide skilled technicians, experienced and familiar with systems being commissioned, to assist Commissioning Agent in commissioning process.

2.4 WORK TO RESOLVE DEFICIENCIES:

- A. If CxA finds non-conforming work, deficiencies during an initial inspection or tests have not been remedied (with exception of un-resolvable deficiencies in 3.b. above), and such remaining deficiencies are significant enough to require additional inspection or re-testing, Contractor will be back-charged for CxA's expenses, and time at a rate of \$150 per hour, for a third and any subsequent re-inspections and re-tests. The Contractor will also be responsible for paying reasonable cost of travel expenses of the following representatives who were physically present for the purpose of witnessing the start-up or the Functional Performance Tests: the CxA, Architect & Engineering team and the Owner. The Owner is entitled to reimbursement or payment from the Contractor under or pursuant to the Contract Documents. If the Contractor fails to promptly make any payment due to the Owner, then the Owner shall have an absolute right to offset such amount against the Contract Sum.
- B. Occupancy Sensors: For projects with more than seven occupant sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each combination are provided not less than 10 percent shall be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested. The General Contractor shall be responsible (not the Owner) to compensate the Commissioning Agent for the additional time/services required to verify the occupant sensor controls to comply with section C408.3.1.1.3 of the 2015 IECC.

2.5 PRE-FUNCTIONAL CHECKLISTS (PFC):

- A. Contractor shall complete Pre-Functional Checklists to validate compliance with Contract Documents installation and start-up requirements, for this Division's systems.
- B. Refer to commissioning plan for detailed list of equipment to be commissioned.
- C. Provide a Test Plan with submittals for equipment to be tested.

2.6 FUNCTIONAL PERFORMANCE TESTING (FPT):

- A. Contractor, in cooperation with Commissioning Agent, shall conduct Functional Performance Testing to validate compliance with Contract Documents.
- B. Assist Commissioning Agent in Functional Testing by removing equipment covers, opening access panels, etc. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.
- C. Refer to commissioning plan for detailed list of equipment to be commissioned.

2.7 TRAINING:

Contractor shall be responsible for training coordination and scheduling, and ultimately to ensure that training is completed.

The training agenda (plan) shall include, at a minimum, the following elements:

- 1. Purpose of equipment.
- 2. Principle of how the equipment works.
- 3. Important parts and assemblies.
- 4. How the equipment achieves its purpose and necessary operating conditions.
- 5. Most likely failure modes, causes and corrections.
- 6. On site demonstration.

2.8 OPERATIONS & MAINTENANCE MANUALS:

- A. Contractor shall compile and prepare documentation for equipment and systems specified in this Division and shall deliver documentation to Contractor for inclusion in Operation & Maintenance Manuals, in accordance with requirements of Division 01, prior to training Owner personnel.
- B. Provide the Commissioning Agent with a hard copy and electronic copy of Operation & Maintenance Manuals for review during the construction process.

END OF SECTION 26 01 06

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all work for electrical systems required in the project to be properly installed, tested and performing their intended function.

1.2 DESCRIPTION OF WORK

- A. The work included under this Section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete electrical systems required by these specifications and/or shown on the drawings of the contract.
- B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, conduit, and outlets. Follow the drawings in laying out the work and verify spaces for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

1.3 QUALITY ASSURANCE

- A. Installers shall have at least 5 years of successful installation experience on projects with electrical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- B. Perform all work in accordance with the latest edition of the national electrical code, and local codes.
- C. All electrical materials and distribution, and utilization equipment shall be UL Listed.
- D. All equipment and materials shall be new and unused and of United States Domestic manufacture unless approved otherwise by engineer or owner.
- E. Eliminate any abnormal sources of noise that are considered by the architect not to be an inherent part of the electrical systems as designed.

1.4 REFERENCES

- A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to all codes, standards and regulations, etc. found in the front end of specifications:
- B. The latest adopted edition by the local and state inspection authorities of all standards and specifications listed in front end shall apply.
- C. Furthermore, the electrical work shall be in accordance with all applicable National and State Standards, and Local Codes and Building Ordinances. The electrical work shall merit the approval of the enforcing authorities having jurisdiction.

1.5 MATERIALS AND EQUIPMENT

- A. Electrical materials and equipment for the entire project shall meet the requirements specified under the Supplementary Conditions Section of this specification.
- B. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable Codes whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures and the point of circuit origin.
- C. The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify all connection details.
- D. All equipment over 50 pounds shall be provided with adequate lifting means.

1.6 COORDINATION WITH OTHER TRADES

- A. Coordinate the work of this division with all other divisions to ensure that all components of the electrical system will be installed at the proper time and fit the available space.
- B. Locate and size all openings in work of other trades required for the proper installation of the electrical system components.
- C. Make all electrical connections to all equipment furnished by this division and any other division.
- D. Make all electrical connections from all 120 volt and greater dampers and switches to associated exhaust fan(s) furnished by any other division.

1.7 DRAWINGS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Determine exact locations by review of equipment manufacturer's data, by job site measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. The size of the electrical equipment indicated on the Drawings may be based on the dimensions of a particular manufacturer. While other listed manufacturers will be acceptable, it is the responsibility of the Contractor to determine if the equipment that Contractor proposes to furnish will fit in the space. The drawings are not intended to show exact locations of conduit and wire, or to indicate all wire terminators, connectors, conduit fittings, boxes or supports, but rather to indicate distribution, circuitry, and control.
- B. The Electrical Drawings are necessarily diagrammatic in character and cannot show every connection in detail or conduit in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Exposed conduit is generally intended to be installed true and square to

the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets and their location details. Work shall be concealed in all finished areas.

1.8 SUBMITTALS

- A. Specification Review:
 - 1. Include a paragraph-by-paragraph written specification review for each product listed requiring a submittal. Denote any proposed deviations from specifications.
- B. Submittals shall be submitted in a 3-ring binder with a tab for each specification section requiring a submittal. Submittal shall be complete and arranged in numerical order and contain all product data, test reports, details, diagrams, etc. as specified in each specification section. Partial submittal submittals will be returned un-reviewed. Submittals for long lead or pre purchase items can be submitted for review in a separate binder with the approval of the Architect/Engineer. Full size shop drawings can be submitted separately but must be submitted at the same time as binder. Submittals can also be submitted electronically in PDF format but must be complete and arranged as noted above. Partial submittals will not be reviewed and will be returned un-reviewed.
- C. Operation and Maintenance Manuals: Operation and Maintenance Manuals shall be provided according to Division 1 requirements. In general, during the time of the contract, and before substantial completion of the electrical installation, submit to the Architect/Engineer three (3) copies of descriptive literature, maintenance recommendations (from the equipment manufacturer), data on initial operation, wiring diagrams, performance curves, engineering data and tests, operating procedures, routine maintenance procedures, and parts lists for each item of electrical equipment installed under this contract and submit all manufacturer's guarantees and warranties.
- D. Shop Drawings: The Contractor shall furnish shop drawing portfolios and proper transmittal forms for all materials, equipment, and lighting fixtures to be incorporated in the work in accordance with the General Conditions, Supplementary Conditions, and all other applicable Conditions.
 - 1. Shop drawings on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function properly as a system. A notation shall be made on each shop drawing submitted as to the item's specific use, either by a particular type number referenced on the drawings or in the specifications, by a reference to the applicable paragraph of the specifications, or by a description of its specific location. The shop drawings shall be organized and bound into sets with each set collated.
 - 2. The Architect/Engineer shall have the final authority as to whether the equipment or material submitted is equal to the specified item. Proposed substitutions may be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

1.9 EXISTING CONDITIONS

- A. Do all work required to maintain electrical services to the Owner occupied portions of the building during construction.
- B. No connection to existing services or utilities shall be made without Owner's knowledge and permission. All such connections shall be planned and scheduled to minimize the length of service interruption required. Request for shutdown shall be made to Owner at least two (2) weeks in advance and shall be accompanied by detailed written schedule of

activities during shutdown and list of materials required for connection and renewal of service. It shall be understood that all such service interruptions shall be made at the Owner's convenience, not the Contractor's. No increase in contract amount will be allowed for reasons of premium time, inefficiency of operations or other considerations not calculated in original bid.

- C. All items removed shall be stored on-site. Schedule a review of the items with the Owner. Remove from site all items the Owner does not choose to keep. Deliver Owner designated items to Owner's storage facility.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

PART 2 – PRODUCTS

- A. Provide allowance in bid for **TEN** 20A/1p circuits of 100 feet in length from source for miscellaneous needs during the course of construction. Include one duplex receptacle per circuit, all associated labor and all necessary accessories (conductor, conduit, supports, etc.) required for proper installation.
- B. Provide allowance in bid for **TEN** light switching circuit drops of twenty feet in length for miscellaneous needs during construction. Include one 277V light switch per circuit, all associated labor and all necessary accessories (conductor, conduit, supports, etc.) required for proper installation.
- C. Provide allowance in bid for **FIVE** additional exit signs for miscellaneous needs during construction. Include circuiting, all associated labor and all necessary accessories required for proper installation.

PART 3 - EXECUTION

3.1 ACCESS TO EQUIPMENT

- A. Starters, switches, receptacles, pull boxes, etc. shall be located to provide easy access for operation, repair and maintenance. If the devices listed above are concealed, access doors shall be provided.

3.2 EXISTING WORK

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction.

- C. When performing work on energized equipment or circuits, use personnel experienced and trained in similar operations.
- D. Remove, relocate, and extend existing installations to accommodate new construction.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.

3.3 EXISTING UTILITIES

- A. The Contractor shall verify the location of all existing utilities with the Owner and Utility Companies prior to commencing excavation work. The drawings and survey data of the contract documents indicate the available information on the existing power and communication services, and on new services to be provided to the project by utility companies. Accuracy of this information is not assured.

3.4 ELECTRICAL SERVICE

- A. The Contractor shall provide all material and pay all fees required by the local utility company for the connection of the new electrical service as shown on the plans. The Contractor shall also meet all equipment requirements of the local utility company. The Contractor shall provide all necessary materials for construction of the temporary electrical service and shall coordinate all details with the local utility company.

3.5 TELECOMMUNICATIONS SERVICE

- A. The telecommunications services to the building are as indicated on the drawings. Arrange all service details with the local telecommunications companies and pay all costs and fees assessed to the project. All work shall be in accordance with the local telecommunications companies' standards and subject to their approval. Coordinate the installation of service entrance equipment with the telecommunications companies prior to the start of construction.

3.6 CUTTING AND PATCHING

- A. The Electrical Contractor shall be responsible for all cutting and patching of holes in building construction which are required for the passage of electrical work. Cutting and patching shall conform to the requirements of Division 1 and, if applicable, Division 2 of these specifications.
- B. Cutting of structural framing, walls, floors, decks and other members intended to withstand stress is not permitted.

3.7 PAINTING, FINISHING

- A. Painting of electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service spaces; and work exposed on the exterior of the facility is specified and performed under other divisions of these specifications.
- B. Factory finishes, shop priming, and special protective coatings are specified in the individual equipment specification sections.
- C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

3.8 EXCAVATION AND BACKFILLING

- A Contractor shall perform all excavation and backfilling necessary to install the required electrical work. Coordinate the work with other excavating and backfilling work in the same area. Except as indicated otherwise, comply with the applicable sections in Division 31 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
- B Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

3.9 CONDUITS AND SUPPORT, GENERALLY

- A Conduits, except electrical conduits run in floor construction, shall be run parallel with or perpendicular to lines of the building unless otherwise noted on the drawings. Electrical conduits shall not be hung on hangers with any other service, unless specifically approved by the Engineer. Electrical conduits shall be hung above all other service pipes. Hangers on different service lines running close to and parallel with each other shall be in line with each other and parallel with, or perpendicular to, the lines of the building. Exact location of electric outlets, piping, ducts, and the like shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.

3.10 ACCESS PANELS

- A. Furnish and install panels for access to junction boxes and similar items where no other means of access, such as a readily removable, sectional ceiling is shown or specified.
- B. Panels shall not be less than 12-inches by 16-inches in size. Larger panels shall be furnished where required. Panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.
- C. Access panels shall be flush type and of all steel construction, with a No. 16 gauge wall or ceiling frame for masonry or plaster and a No. 14 gauge panel door. Doors shall be secured with concealed hinges and flush locks of either the cylinder type or approved, positive acting, screwdriver operated type. Doors for wall panels may be secured with suitable clips and countersunk screws. Panels shall be painted with a rust-inhibitive primer at the factory. Panels in rated wall shall also be rated.

3.11 INSTALLATION OF EQUIPMENT

- A. Install and connect all appliances and equipment as specified and indicated for this project, in accordance with the manufacturers' instructions and recommendations. Furnish and install complete electric connections and devices as recommended by the manufacturer or required for proper operation

3.12 COORDINATION

- A. Coordinate the electrical work with work of the different trades so that:
 - 1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
 - 2. Within the limits indicated on the drawings, the maximum practicable space for operation, repair, removal and testing of electrical and other equipment will be provided.
 - 3. Pipe, conduits, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes,

conduits, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.

- B. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.
- C. Before any sleeves or inserts are set, or any electrical equipment or foundations are installed, prepare and submit for approval composite coordination drawings for all equipment rooms, and other areas in which work of two or more trades or subcontractors is to be installed and in which the probability of interference exists. Drawings shall show the work of all trades covered, shall be drawn to a scale not smaller than $1/2" = 1'-0"$, and shall show clearly in both plan and elevation that all work can be installed without interference.
- D. Any work installed prior to approval of coordination drawings shall be at the Contractor's risk. Subsequent relocations required to avoid interference's shall be made without additional expense to the Owner.

3.13 OWNER INSTRUCTION

- A. Provide on-site Owner training for all new equipment.
- B. Use Operation and Maintenance manuals and actual equipment installed as basis for instruction.
- C. At conclusion of on-site training program have Owner personnel sign written certification they have completed training and understand equipment operation. Include copy of training certificates in final Operation and Maintenance manual submission.

3.14 AS-BUILT DRAWINGS

- A. Contractor shall provide the Owner with as-built drawings for all electrical systems as described in these specifications and/or shown on the Drawings.

END OF SECTION 26 05 00

SECTION 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete system of building wire and cable to all electrical loads.

1.2 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Provide stranded conductors for all wiring.
 - 2. Conductor not smaller than 12 AWG for power and lighting circuits.
 - 3. Conductor not smaller than 16 AWG for control circuits.
 - 4. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet
 - 5. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.
 - 6. Copper.
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only Type THHN/THWN insulation, in raceway.
- C. Branch Circuit Conductors: No branch circuit conductors are allowed in any slab or under slab on grade unless specifically indicated on drawings.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of electric wire and cable products of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Qualified with at least 5 years of successful installation experience on projects with electrical wiring work similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable and connectors.
- B. UL Compliance: Comply with UL standards pertaining to wire cable and connectors.
- C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.
- D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.
- E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.
- F. IEEE Compliance: Comply with applicable portions of IEEE standards pertaining to wire and cable.

- G. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation
- B. Submit manufacturer's data on electric wire and cable.

1.6 COORDINATION

- A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Manufacturers:
1. Southwire
 2. The Okonite Company
 3. Diamond Wire & Cable Co.
 4. General Cable Co.
 5. Advance Wire and Cable, Inc.
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation: NFPA 70; Type THHN/THWN insulation for feeders and branch circuits.

2.2 WIRE, CABLE, AND CONNECTORS

- A. General: Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation.
- B. WIRE:
1. All conductors shall be 600-volt and shall be copper with insulation of the following types, unless otherwise noted on the drawings or in these specifications.
 2. For dry locations, provide Type THHN conductors. Conduit sizes are based on type THHN wire.
 3. For damp or wet locations, provide Type THWN conductors.
 4. Provide Type THWN conductors for service entrance cabling or feeders direct buried, or installed in underground raceways. Provide Type THWN conductors for branch circuit conductors installed in underground raceways.
 5. No wire shall be smaller than No. 12 AWG, except that wiring for signal and pilot control circuits may be No. 14 AWG, and pre-manufactured fixture whips for light fixtures may be No. 14 AWG.
 - a. Use preinsulated connectors 3M Company "Scotchlok," or Ideal Industries, Inc. "super nut," for splices and taps in conductors No. 10 AWG and smaller. All other twist-on connectors must be reviewed by the

- Architect prior to installation. Use this type of connector for factory-made splices in fixtures or equipment.
- b. Pressure indent type connectors must be submitted to the Architect for review.
 - c. Tape all splices and joints with vinyl plastic tape manufactured by Minnesota Mining and Manufacturing Company. Use sufficient tape to secure insulation strength equal to that of the conductors joined.
 - d. Keep splices in underground junction boxes to an absolute minimum. Where splices are necessary, use resin pressure splices and resin splicing kits manufactured by the 3M Company, St. Paul, Minnesota, to totally encapsulate the splice. Arrange the splicing kit to minimize the effects of moisture.
- 6. Connect wire No. 6 AWG and larger to panels and apparatus by means of approved lugs or connectors.
 - 7. All wire shall be stranded.
 - 8. Connectors of the porcelain cup type with or without metal inserts shall not be used, including all splices in fixtures which are made in advance by the fixture manufacturer. Splices in wire No. 8 AWG and larger shall be made with approved solderless lugs. If any type of pressure indent type connector is proposed for use on any size conductor, it shall be specifically submitted for approval prior to use.
 - 9. Wire sizes shown are minimum based on code requirements, voltage drop and/or other considerations. Larger sizes may be installed at the Contractor's option to utilize stock size, provided conduit sizes are increased where necessary to conform to the National Electrical Code. Sizes of wires and cables indicated or specified are American Wire Gage (Brown and Sharpe).

2.3 TYPE MC CABLE

- A. Manufacturers:
 - 1. AFC
 - 2. Southwire
- B. Product Description: A fabricated assembly of insulated conductors in a flexible metallic enclosure.
- C. Comply with NEC 320.
- D. Support, provide separate support to structure for all Type MC cable, spacing not exceeding three (3) feet and at each junction box.
- E. Provide an insulated green grounding conductor in all Type MC cable.
- F. Acceptable Use: Install, at Contractor's option, only for service to light fixtures above accessible ceilings, limit length to six (6) feet whips from accessible junction box to light fixtures.
- G. Provide insulated throat fittings at all terminations of Type MC cable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.2 EXISTING WORK

- A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

3.3 INSTALLATION

- A. General: Install electric cables, wires and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized wherever required.
- D. Splicing: No splicing or joints will be permitted in either feeder or branch circuits except at outlet or accessible junction boxes.
- E. Wire shall not be installed in raceways until the concrete work and plastering is completed and all conduits in which moisture has collected have been swabbed out. Insulation resistance to ground shall not be less than that approved by NEC. Eliminate splices wherever possible.
- F. Use pulling compound or lubricant where necessary. Compound must not deteriorate conductor insulation.
- G. Prior to energization, check cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.
- H. Bury a continuous, pre-printed, bright colored plastic ribbon cable marker with each underground cable, regardless of whether conductors are in conduit. Locate each directly over cables 12" below finished grade.

- I. Conductor Installation: Install all conductors in a single raceway at one time, insuring that conductors do not cross one another while being pulled into raceway. Leave sufficient cable at all fittings or boxes and prevent conductor kinks. Keep all conductors within the allowable tension and exceeding the minimum bending radius.
- J. Conductor Support: Provide conductor supports as required by the code and recommended by the cable manufacturer. Where required, provide cable supports in vertical conduits similar to OZ Type C.M.T., and provide the lower end of conduit with OZ Type KVF ventilators.
- K. Conductor Termination: Provide all power and control conductors that terminate on equipment or terminal strips, with solderless lugs or fork and flanged tongue terminals. Provide T and B "sta-kon" tongue terminal. This type conductor termination is not required when the equipment is provided with solderless connectors.
- L. Many circuits are shown on the drawings to be provided with dedicated neutral and ground conductors. Carefully review circuiting and the electrical abbreviations and symbols legend and provide the number of conductors indicated.
- M. Route wire and cable to meet Project conditions.
- N. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- O. Identify and color code wire. Identify each conductor with its circuit number or other designation indicated.
- P. Special Techniques - Wiring Connections:
 - 1. Clean conductor surfaces before installing lugs and connectors.
 - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - a. MDF/IDF room branch circuits: All branch circuits shall be dedicated and unspliced. Provide dedicated branch circuit 20 or 30 amperes, #10 and or #12 wire, unspliced from wiring device all the way back to the overcurrent device. Do not share ground with any other circuit.
 - b. Computer branch circuits: All branch circuits shall be dedicated. Provide dedicated branch circuit 20 amperes, #10 and or #12 wire from wiring devices all the way back to the overcurrent device. Do not share neutral with any other circuit.
 - c. Kitchen branch circuits: All branch circuits for 125 volt, single phase, 15 and 20 ampere receptacles shall be dedicated. Provide dedicated branch circuit 20 amperes, #10 and or #12 wire from wiring devices all the way back to the overcurrent device. Do not share neutral or ground with any other circuit.
 - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
 - 4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
 - 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 WIRE COLOR

A. COLOR CODES FOR CONDUCTORS FOR BRANCH CIRCUITS AND FEEDERS

| | Wire Sizes #10 and Smaller: Use Continuous Color Coded Insulation (Note 01) | | | | Wire Sizes #6 and Smaller: Use Continuous Color Coded Insulation (Note 02) | |
|---------------------|---|--------|--------|--------------------------------|---|---------------------|
| <u>System/Phase</u> | A | B | C | N | G | IG |
| 120/208 | Black | Red | Blue | White | Green | Green/Yellow Stripe |
| 120/240 | Black | Orange | Blue | White w/color stripe (Note 03) | Green | Green/Yellow Stripe |
| 277/480 | Brown | Purple | Yellow | Gray | Green | Green/Yellow Stripe |

Table Notes:

1. Wire size #8 and larger, black conductors with color marking tape at each termination and where accessible; colors as noted above.
2. Wire sizes #4 and larger, black conductor with green marking tape at each termination and where accessible.
3. Provide white (no stripe) insulation when 120/208V system is not present at this installation.

- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number and provide color coding at each junction box containing more than one neutral.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
For 6 AWG and smaller: Green.
For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.5 GROUPING OF CIRCUITS

- A. Limit the number of current carrying conductors per conduit to 6. Neutrals serving computer receptacle branch circuits shall be counted as current carrying. Grounds shall not be counted.
- B. Grouping of different voltages is not allowed.
- C. Grouping of conductors of the same phase in not allowed.
- D. Provide metal box sizes per NEC Table 314.16 (A).

- E. Provide conduit per NEC Annex C.
- F. Neutrals serving branch circuits shall not be shared. Provide dedicated neutral per circuit.

3.6 POWER LIMITED CIRCUIT INSTALLATION

- A. Provide a complete system of raceway and covered junction boxes for all power limited circuits installed exposes in finished spaces and spaces without a ceiling.
- B. Provide raceway for all power limited circuit wiring within wall cavities and above sheet rock, plaster and other "hard" (non-lay-in) ceiling types of construction.
- C. Labeling: Provide label on all junction boxes.
 - 1. Provide permanent labeling with indelible black marker, in neat, legible print indicating the system wiring name.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a continuous low-impedance grounding system for the entire electrical wiring system.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
 - 3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 pertaining to electrical grounding.
- B. NFPA 70 - National Electrical Code.
- C. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.
- D. UL Compliance: Comply with applicable requirements of UL Standard Nos. 467 and 869 pertaining to electrical grounding and bonding.
- E. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.
- F. Utility: Grounding shall be done so as to comply with all applicable grounding requirements and rules of the serving utility.
- G. NECA Compliance: Comply with NECA's "Standard of Installation."

1.3 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Concrete-encased electrode.
 - 4. Ground ring.
 - 5. Rod electrode.
 - 6. Plate electrode.
- B. Applications of grounding work in this Section include the following:
 - 1. Underground Metal Piping
 - 2. Underground Metal Water Piping
 - 3. Metal Building Frames
 - 4. Ground Rods

- 5. Separately Derived Systems
- 6. Service Equipment
- 7. Enclosures
- 8. Equipment

- C. Requirements of this Section apply to electrical grounding work specified elsewhere in these specifications.

1.4 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: Submit data on grounding electrodes and connections.

1.5 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.
- B. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been of satisfactory use in similar service for not less than three years.
- C. Installer: Qualified with at least three (5) years' experience on projects with electrical grounding work similar to that required for this project.

1.6 GROUND RING PRE-INSTALLATION MEETINGS

- A. This paragraph shall apply to buildings when a ground ring is specified.
- B. Convene minimum one (1) week prior to commencing work of this section.
- C. Coordinate with concrete pour schedule for footings to insure rebar in concrete is available for bonding.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: Subject to compliance with the requirements, provide grounding products of one of the following:

- A. B-Line Systems
- B. Burndy Corporation
- C. Crouse Hinds
- D. Copperweld Inc.
- E. Erico Inc.

- F. Electrical Components Div.; Gould Inc.
- G. General Electric Supply Co.
- H. Ideal Industries, Inc.
- I. O-Z Gedney Co.
- J. Thomas and Betts Corp.
- K. VFC
- L. Western Electric Co.

2.2 GROUNDING SYSTEMS:

- A. Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including but not limited to cables/wires, connectors, terminals, ground rods/electrodes, bonding jumper braid, and additional accessories needed for a complete installation. Where more than one type unit meets indicated requirements, selection is installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.

2.3 CONDUCTORS:

- A. Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC requirements.
- B. Material: Stranded copper.
- C. Foundation Electrodes: #2 AWG.
- D. Grounding Electrode Conductor: Copper conductor bare.
- E. Bonding Conductor: Copper conductor bare.

2.4 BONDING JUMPER BRAID:

- A. Provide copper braid tape, constructed of 30 gage bare copper wires and properly sized for indicated applications.

2.5 FLEXIBLE JUMPER STRAP:

- A. Provide flexible flat conductor, 480 strands of 30 gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cmil. Protect braid with copper bolt hole ends with hole sized for 3/8" dia. bolts.

2.6 BONDING PLATES, CONNECTORS, TERMINALS AND CLAMPS:

- A. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.

2.7 GROUND RODS:

- A. Provide copper-clad steel, 3/4" dia. x 10'.

2.8 ELECTRICAL GROUNDING CONNECTION ACCESSORIES:

- A. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by accessories manufacturers for types of service indicated.
- B. UL Listed for grounding applications.
- C. Description: Brass connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.9 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Cadweld by Erico, Inc.
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.10 GROUNDING BUSSES

- A. When indicated, provide copper ground busses on walls in areas where special grounding needs will arise. Bus shall consist of copper bar as follows:
 - 1. Ground bar cross section of nominal four (4) inches by 1/4 inch; 24 inches length.
 - 2. Drill to accommodate NEMA Pattern D 2-hole compression lugs for ground wires to be installed. Leave remainder of bar for future drilling by owner.
 - 3. Copper compression lugs to connect conductors to the bar. Lugs shall be 2-hole type for double bolting to ground bar.
 - 4. Install all bolts for compression with top and bottom steel washers plus a Belleville spring washer between top washer and bolt head.
 - 5. Grounding electrode conductor(s) shall be fusion-welded on buss (and not lugged on).
 - 6. Mounting Free air, no enclosure required. Install Harger WBKT-1 brackets to mount bar to wall. Isolate copper bar from mounting brackets with Harger 4200-Series two (2) inch insulators.
 - 7. Fasten clear pexiglass cover on standoff bolts over ground bar. Engrave cover "GROUND BUS". Cover by Harger Lightning Protection, Inc., or approved equal.
 - 8. Ground bar assembly shall be Harger Lightning Protection, Inc. GBI Series (800-842-7437, www.harger.com), Erico, Inc. (800-248-9353) or approved equal.

2.11 DRIVEN ELECTRODE ACCESS WELL AND COVER

- A. Eight (8) inch diameter concrete pipe with belled end.
- B. 24 inches long or longer to reach ground and set flush in grade.
- C. Provide cast iron cover with "GROUND" embossed on top.

PART 3 – EXECUTION

3.1 GENERAL

- A. Inspection: Installer must examine areas and conditions under which electrical grounding connections are to be made and notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. General: Install electrical ground systems where shown, in accordance with applicable portions of the NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- C. Coordinate with other electrical work as necessary to interface installation of electrical grounding systems with other work.
- D. Grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded shall be accomplished for temporary and permanent construction.
- E. Provide a separate green equipment ground conductor in all electrical raceways to effectively ground all fixtures, panels, receptacles, controls, motors, disconnect switches, exterior lighting standards and noncurrent carrying metal enclosures. The ground wires shall be connected to the building system ground. NEC Table 250-95 shall be used to size the ground conductor if the size is not shown on the drawings.
- F. To satisfy the "effective grounding" requirements of the NEC the path to ground from circuits, equipment, and conductor enclosures shall be permanent and continuous and shall have ample carrying capacity to conduct safely any currents liable to be imposed on it, and shall have impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.
- G. At the service entrance equipment, bond the utility neutral, building neutral and building ground conductor to a common ground bus (or ground lug). Connect the ground bus to the building domestic cold water pipe with a grounding conductor and an approved clamp and connector. Install the grounding conductor in exposed PVC conduit and make connections readily accessible for inspection. The point of connection to the water service shall be as near the building entrance as possible. Provide a copper wire shunt of the same size as the ground conductor around the water meter and clamp to the water pipe with bronze fittings. Bond the water pipe to the structural steel system of the building and reinforcing bars in footings when such building construction occurs.
- H. In addition to the requirements for service entrance grounding listed above, provide a supplemental grounding electrode consisting of driven ground rods (three 10 foot x 3/4 inch copper-clad steel ground rods).

- I. Clean the contact surfaces of all ground connections. Remove paint, rust, mill oils, and surface contaminants at connection points.
- J. Where separately derived systems occur, ground the system to a grounding electrode acceptable to the code.
- K. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment. At the point of electrical service entrance, bond all metallic raceways together, with a ground conductor, and connect to the system ground bus. Bond all boxes as specified for equipment.
- L. Receptacles: Permanently connect the ground terminal on each receptacle to the green ground conductor.
- M. Motors: Connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted, solderless lug.
- N. Provide a flexible ground strap (No. 6 AWG) at each flexible duct connection to air handlers, exhaust fans, and supply fans. Install straps to preclude vibration.
- O. Provide necessary ground connections to telephone service entrance equipment. Verify requirements with the local telephone company.

3.2 EXAMINATION

- A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.3 EXISTING WORK

- A. Modify existing grounding system to maintain continuity to accommodate renovations.
- B. Extend existing grounding system using materials and methods compatible with existing electrical installations.

3.4 INSTALLATION

- A. Install in accordance with NEC Article 250. Properly bond the system neutral to the system grounding electrode conductor at the main service entrance equipment. All other neutral busses, bars, etc. on the service voltage system shall be isolated from ground. This system shall be the solid grounded type.
- B. Bond all ground electrodes together to form the grounding electrode system including metal underground water pipe, metal frame of the building or structure, concrete encased electrodes, ground ring, rod and pipe electrodes and plate electrodes.
- C. Install grounding and bonding conductors concealed from view.
- D. Install grounding electrode conductor and connect to reinforcing steel in foundation footing.
- E. Install a green equipment grounding conductor in all feeders and branch circuits, minimum size per NEC Table 250.122.

- F. Transformers: Ground as a separately derived source.
 - 1. Where transformer secondary includes a neutral, the neutral shall be bonded to the equipment enclosure and connected to the system ground conductor.
 - 2. Size bonding jumper per NEC Table 250.66.
 - 3. Grounding conductor shall be in raceway and shall be bonded to nearest available point of interior metal water piping system.
- G. Bond together reinforcing steel and metal accessories in pool and fountain structures.
- H. Concrete-Encased Electrode (NEC 250-52):
 - 1. Concrete-encased electrode also known as the "Ufer ground" consisting of either a min. 1/2" continuous reinforcing bar or bare copper conductor not smaller than a #4AWG. Electrode to be installed in min 2" of concrete and located horizontally within a portion of a concrete foundation or footing that is in direct contact with the earth and located at the building periphery nearest the electrical service. Unless otherwise noted on drawings, the designated footings are the perimeter building corners plus perimeter footings.
- I. Made Electrode:
 - 1. Triple Ground Rod: Provide a building ground rod and bond it to the electrode system. The building ground rod shall consist of three ground rods, arranged in an equilateral triangular pattern located at least five (5) feet outside an exterior building wall or as otherwise directed. Space 15 feet apart and drive into the earth to a point two (2) feet below finished grade to top of rods. Grounding electrode conductor shall form a continuous loop around rods, and conductor shall be properly bonded to each rod by a fusion weld similar to "Cadweld".
 - 2. Extend grounding electrode conductor from this ground rod(s) to the grounded service conductor (neutral) in the building main switchboard at an accessible point on the ground bus per NEC 250-24.
 - 3. Install grounding electrode conductor of 3/0 Copper.
- J. Main Bonding Jumper: Shall be sized in accordance with Section 250-66, if not indicated on the drawings, and installed within the same enclosure as the point of bonding of the system neutral service entrance.
- K. Grounding Busses:
 - 1. Provide a copper bus bar where indicated on Drawings. Provide grounding electrode conductor and connection to the grounding electrode system. AWG No. 2 minimum.
 - 2. Provide in each IDF and MDF room.
 - 3. Provide at each CATV / MATV head-end mounting board.
 - 4. Provide at each building communications rack.
 - 5. Provide at each sound reinforcement equipment rack.
- L. Water Pipe Electrode: A ten (10) foot minimum length of electrically continuous underground metal water pipe. Bond around insulating joints or sections, insulating pipe, and water meters to make pipe electrically continuous.
- M. Metal Building Frame NEC 250-52.
 - 1. The structural steel or other metal frame of the building. Effectively ground the steel structural columns to the ground ring grounding electrode conductor.
 - 2. Cadweld #2 AWG bare copper cable to base of steel column. Route bonding jumper down through column blockout in building floor slab, excavate under grade beam, and extend out to the ground ring. Cadweld jumper (also called "stinger") or install Burndy Hyground™ Type YGHP-C hydraulic compression

connector onto ground ring. Install a ground rod at each point where a stinger from a building steel column lands on the ground ring.

- N. Ground Ring Electrode (NEC 250-52):
 - 1. Provide a tinned, bare copper conductor, size AWG #2 or larger, ground loop in direct contact with the earth. Install ground ring min. 5'-0" outside of building and below the entire periphery of the building at least 36 inches underground. The ring conductor shall be in direct contact with the earth and below any concrete mat or seal slab that may be part of the building structural foundation. Bond this ground ring to all other electrodes and to the grounded service conductor (neutral) in the building main switchboard at a point on the supply side of each service disconnect.
- O. Fuel Gas Piping:
 - 1. Each above ground portion of a gas piping system upstream from the equipment shutoff valve shall be made electrical continuous and bonded to the building grounding electrode system, as required in NFPA 54, National Fuel Gas Code.
 - 2. Gas piping shall not be used as a grounding electrode.
- P. Outdoor Lighting Poles:
 - 1. All metallic outdoor poles and luminaries on metallic or non-metallic lighting poles shall be grounded by bonding in an approved manner to the circuit grounding conductor. In addition to this, bond pole to a #8 bare copper wire which shall also be bonded to a ground rod. Install the ground rod adjacent to the pole base with the top driven at least two (2) feet below grade.

3.5 OTHER GROUNDING SYSTEMS:

- A. General Check the drawings for special grounding system or grounding requirements.
- B. Telephone and data equipment grounding connections:
 - 1. Bond each telephone and data equipment ground (buss type or grounding conductor type) at each telephone terminal board and data rack back to the service entrance grounding electrode system with a bare #6awg ground wire.

3.6 EQUIPMENT GROUNDING SYSTEM

- A. General: Make a firm bond between all enclosures, equipment and metallic raceway system. Grounding conductors shall be continuous from origin to termination and properly bonded with lugs at both ends. The metallic raceway systems shall be made up properly to form a grounding path that has an impedance back to the main system ground that is as low as can be practically obtained.
- B. Over 250 Volts: Provide locknuts and/or listed fittings per NEC 250-97 for bonding of metal raceways in all circuits of over 250 Volts to ground. In case of oversized, concentric or eccentric knockouts, comply with NEC 250-92(B). The use of snap-in, wedge-type, or pivot-type connectors is prohibited.

3.7 FIELD QUALITY CONTROL

- A. Grounding Tests:
 - 1. Test the electrical system after installation is complete. Inspect and test for stray currents, unintended ground shorts, and proper physical condition of grounding system. Correct any deficiencies and re-test to verify satisfactory installation.

2. Provide written test report to document all findings, test values, work done and certification of grounding system.
3. Use true-RMS meters for all voltage and current measurements.
4. Test telecommunications grounding riser to verify continuity.
5. Check all isolated ground receptacles for correct polarity.
6. Test all sub panels of separately derives systems to verify subpanel neutral is isolated from ground.
7. Verify continuity and isolation of audio system ground bus and grounding riser.
8. Perform ground resistance and continuity testing in accordance with IEEE 142.
9. When improper grounding is found on receptacle, check receptacles in entire project and correct. Perform retest.

3.8 TEST WELLS

- A. Install test well for designated outdoor driven ground rods. Set tops of well flush with finished grade. Provide mechanical connector for ground rod inside test well so that rod can be disconnected from ground ring or other grounding electrode system for testing.
 1. Designated Ground Rods:
 - a. One (1) at triple ground rod for High School Main Switchboard Electrical Room.
 - b. One (1) at each generator.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping relating to electrical work.
 - 7. Firestopping accessories.
 - 8. Equipment bases and supports.

1.2 REFERENCES

- A. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL - Fire Resistance Directory.

1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to Building Code and UL for fire resistance ratings and surface burning characteristics.

1.5 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with the Building Code.

PART 2 - PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. Electroline Manufacturing Company
 - 3. O-Z Gedney Co.
 - 4. Appleton
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Midland Ross Corporation, Electrical Products Division
 - 4. Unistrut Corp.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SLEEVES

- A. Sleeves for raceway Through Non-fire Rated Floors: 18 gage galvanized steel.
- B. Sleeves for raceway Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.
- C. Sleeves for raceway Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL Listed.
- D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.4 SPRING STEEL CLIPS

- A. Product Description: Mounting clamp, and screw.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation

- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FIRESTOPPING

- A. Manufacturers:
 - 1. Dow Corning Corp.
 - 2. Fire Trak Corp.
 - 3. Hilti Corp.
 - 4. International Protective Coating Corp.
 - 5. 3M fire Protection Products .
 - 6. Specified Technology, Inc.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
 - 1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
 - 2. Foam Firestopping Compounds: Multiple component foam compound.
 - 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 - 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
 - 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 - 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 - 7. Firestop Pillows: Formed mineral fiber pillows.

2.7 FIRESTOPPING ACCESSORIES

- A. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- B. General:
 - 1. Furnish UL Listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- C. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 - 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.2 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors or preset inserts as required.
 - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners or welded fasteners as required.
 - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors as required.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts or hollow wall fasteners as required.
 - 5. Solid Masonry Walls: Provide expansion anchors or preset inserts as required.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over four (4) inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.
- D. Do not fasten supports to suspended ceiling support system, pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards one (1) inch off wall.
 - 4. Support vertical conduit at every floor.

3.3 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.

- E. Place intumescent coating in sufficient coats to achieve rating required.
- F. Remove dam material after firestopping material has cured.
- G. Fire Rated Surface:
 - 1. Seal opening at all rated floors and walls as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL Listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, bus, or conduit, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- H. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated floors and walls as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

3.4 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Provide mechanical sleeve seals.
- B. Interior conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors and walls one (1) inch above finished floor level. Caulk sleeves.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, wireways, outlet boxes, pull and junction boxes, and handholes.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- C. UL Compliance and Labeling:
 - 1. Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Each length of raceway shall bear the Underwriters Laboratories label.
- D. NEC Compliance:
 - 1. Comply with NEC requirements which are applicable to the construction and installation of raceway systems
- E. NECA Compliance:
 - 1. Comply with NECA's "Standard of Installation".

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Wet and Damp Locations: Provide rigid steel conduit. Provide weather resistant, cast metal junction and pull boxes. Provide flush mounting outlet box in finished areas. Boxes shall be sealed to prevent air and water infiltration through the building envelope.

- C. Concealed Dry Locations: Provide rigid steel intermediate metal conduit on electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- D. Exposed Dry Locations: Provide rigid steel conduit, intermediate metal conduit or electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- E. In Slab or Under Slab on Grade: No branch circuit raceway is allowed in any slab or under slab on grade unless specifically indicated on drawings.
- F. Types of raceways in this Section include the following:
 - 1. Electrical metallic tubing.
 - 2. Flexible metal conduit.
 - 3. Intermediate metal conduit.
 - 4. Liquid-tight flexible metal conduit.
 - 5. Rigid metal conduit.
 - 6. PVC Rigid nonmetallic conduit.
 - 7. PVC-Coated Rigid Steel Conduit.

1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch.

1.5 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each type of device specified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

1.7 COORDINATION

- A. Coordinate installation of outlet boxes for equipment connected under other Divisions.
- B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes. Refer to Architectural elevations and equipment specifications and coordinate device locations prior to electrical rough-in.

PART 2 - PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied
 - 2. Wheatland
 - 3. Republic
 - 4. Cantex
 - 5. Western
 - 6. Prime
 - 7. or approved equal.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Intermediate Metal Conduit (IMC): Rigid steel.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit
- E. Electrical Metal Tubing (EMT): All EMT fittings shall be steel not die-cast metal. All conduit stub-ups above ceiling for low voltage and data to be provided with insulating bushing.
- F. Flexible Metal Conduit (Flex): Conduit fittings shall be steel. Provide plastic anti-short bushing for all flex fittings. Comply with NEC 348.
- G. Liquidtight Flexible Metal Conduit: Shall be same as flexible metal conduit specified above except Article 350 in NEC.
- H. PVC-Coated Rigid Steel Conduit: Galvanized rigid steel with additional external coating for 40 mil polyvinyl chloride jacket (PVC). Conforming to UL Standard 6. ANSI C80.1 and NEMA Standard No. RN.1.
 - 1. Manufacturer:
 - a. Ocal Inc.
 - b. Perma Cote Industries
 - c. Rob-Roy Industries
 - d. or Approved equal.
- I. PVC-Rigid Nonmetallic Conduit: PVC and fittings that are listed per the UL Standards. Comply with NEMA Standard TC-2.
- J. Nonmetallic Multi Duct: Provide nonmetallic multi duct that is UL Listed.
 - 1. Type: four (4) inches schedule 40 PVC outer duct, four 1.25 inch ducts of ribbed polyethylene. Duct shall have six (6) inch deep end bell on one end, spigot on the other end.
 - 2. Multi Duct shall have gaskets to seal the inside and outside walls of the inner duct.

2.2 ENCLOSURE

- A. Pull Boxes, Junction Boxes, Cabinets, and Wireways: Provide pull boxes, junction boxes, wireways, and cabinets wherever necessary for proper installation of various electrical systems according to the National Electrical Code and where indicated on the Drawings.

- B. Minimum Size: That size shown on the drawings, as required for the specific function, or as required by the National Electrical Code, whichever is larger.
- C. Construction:
 - 1. Indoors in Dry Areas and Not Buried in Slab: Code gage steel - NEMA 1 construction - sides formed and welded, screw covers unless indicated hinged cover or door on drawings. Hinged doors shall be similar to panelboard doors with the same type locking device. Knockouts shall be factory made or formed O-Z Gedney Type PB or approved equal.
 - 2. Outdoors or Indoors in Wet Areas and Not Buried in Slab: Same as specified above for indoor except provide NEMA 3R (designated by 3R or RT) unless indicated or specified to be NEMA 4 (designated by 4 or WP) or other type rating.
 - 3. Indoors Buried in Slab: Watertight, galvanized cast iron in floors on or below grade, otherwise concrete tight stamped steel.
 - 4. Outdoors Buried in Earth: Watertight, galvanized cast iron with a six (6) inch reinforced concrete envelope, polymer concrete casting similar to Strongwell "Composolite" (www.strongwell.com; former MMG Quazite) or precast concrete type manufactured by Brooks Product, Inc brand for Oldcastle Precast, Inc. (713-991-2400). Precast box shall have appropriate structural rating for intended use. Install on a level poured concrete base to provide a solid bearing surface. Provide a bolted cast iron traffic cover with foundry-cast marking "Electrical", "Communications" or "Telephone" as applies. Top of enclosure shall be one (1) inch above finished grade in earth. Top of enclosure shall be flush with finished pavement.

2.3 WIREWAY

- A. Manufacturers: Same as Metal Conduit.
- B. Product Description: General purpose.
- C. Size: As determined by Contractor in accordance with NEC 376.
- D. Cover: Screw cover.
- E. Connector: Slip-in.
- F. Fittings: Lay-in type.
- G. Finish: Rust inhibiting primer coating with gray enamel finish.

2.4 OUTLET BOXES

- A. Manufacturers: Same as Metal Conduit.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- C. Cast Boxes: NEMA FB 1, Type FD, cast fer alloy. Furnish gasketed cover by box manufacturer.
- D. Wall Plates: As specified in Section 26 27 26.

2.5 FLOOR BOXES

- A. UL listed for wet application, watertight cast-iron.
- B. NEMA OS-1, sheet steel outlet boxes, device boxes, covers, and box supports.
 - 1. Floor: Fully adjustable before and after pour.
 - 2. UL Listed for wet application when installed into concrete, stone, tile or floor without carpet cover. Provide carpet flange where installed in carpet.
 - 3. Provide watertight, cast iron on floors at or below grade, and provide concrete tight stamped steel on all upper floors.
 - 4. Multi Gang Floor Box: Fully adjustable watertight cast iron gang floor boxes where shown on Drawings. Provide with removable partition and provide conduit openings in boxes as required. Install power circuits in separate raceway from data, telephone or other signal.
- C. Manufacturers:
 - 1. Appleton
 - 2. Carlon
 - 3. Crouse-Hinds
 - 4. Hubbell
 - 5. Thomas & Betts / Steel City
 - 6. Walker
 - 7. Wiremold

PART 3 - EXECUTION

3.1 GENERAL

- A Install electric raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation" and complying with recognized industry practices.
- B Raceways embedded in concrete or in earth below floor slabs shall be rigid steel conduit, intermediate metal conduit or rigid schedule 40 PVC conduit. Rigid PVC conduit shall be provided with rigid metal or intermediate metal conduit elbows when the raceway system exits the concrete topping or earth.
- C Electrical metallic tubing shall not be embedded in concrete or installed in earth.
- D Aluminum conduit shall not be embedded in concrete, or installed in earth.
- E Rigid heavy wall Schedule 40 PVC conduit shall be installed in earth and concrete only.
- F Raceways in outside walls or in refrigerated areas shall be rigid steel conduit, or intermediate metal conduit.
- G Provide rigid steel conduit or intermediate metal conduit for exposed raceways from floor to eight feet above the floor in mechanical rooms and in areas designated on the plans.
- H Rigid galvanized steel conduit or galvanized intermediate metal conduit shall be used where conduit is exposed to weather.
- I Conduits in hazardous locations shall conform to the National Electrical Code. Rigid galvanized steel conduit or intermediate metal conduit shall be used in hazardous locations. PVC conduit shall not be used in hazardous areas.

- J Rigid metal, intermediate metal, electric metallic tubing or PVC conduit where allowed in other section 3.1 paragraphs shall be used for feeders and branch circuits.
- K Flexible metal conduit may be used to connect light fixtures in accordance with NEC requirements. Provide flexible metal conduit for connections to motors, transformers, generators, and other equipment subject to vibration. Length of flexible conduit shall be a minimum of one foot for conduit diameters up to 1-1/2". A minimum of 3" of flexible conduit shall be added for every 1/2" increase in conduit diameter. Flexible metal conduit installation shall be kept to a minimum in connecting other electrical equipment items.
- L Sealtight, flexible conduit shall be used where the flexible conduit may be subject to moist or humid atmosphere, corrosive atmosphere, subject to water spray and subject to dripping oil, grease or water.
- M Conduits shall be 3/4" diameter, minimum. Raceway sizes shown on the drawing are based on type THHN/THWN copper conductors.
- N Type Material: Except as noted otherwise all conduit shall be steel.

3.2 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.3 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.4 INSTALLATION - RACEWAY

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 25 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.
- E. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

- F. Arrange raceway supports to prevent misalignment during wiring installation.
- G. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- H. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29.
- I. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- J. Do not attach raceway to ceiling support wires or other piping systems.
- K. Construct wireway supports from steel channel specified in Section 26 25 29.
- L. Route exposed raceway parallel and perpendicular to walls.
- M. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- N. Maximum Size Conduit in Slab Above Grade: 3/4 inch.
- O. Maintain clearance between raceway and piping for maintenance purposes.
- P. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees Fahrenheit.
- Q. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- R. Bring conduit to shoulder of fittings; fasten securely.
- S. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- T. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- U. Provide accessible "seal-off" fittings for all raceways entering or leaving hazardous areas, entering or leaving refrigerated areas and as otherwise required by the National Electrical Code.
- V. Where conduits penetrate the roof seal, they shall be installed in curbs provided for mechanical equipment. When this is not possible, suitable pitch pockets, lead flashing, or approved fittings shall be provided. Details for special conduit installations shall be as shown on the drawings.
- W. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate factory elbows for bends in metal conduit larger than two (2) inch size.
- X. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- Y. Install fittings to accommodate expansion and deflection where raceway crosses expansion joints.
- Z. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

- AA. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- BB. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- CC. Close ends and unused openings in wireway.
- DD. Provide tracer wire on all underground raceway outside building slab on grade.

3.5 RACEWAY TYPES

- A. The following raceway types are to be used in the following locations:
 - 1. Underground: Concrete encased schedule 40 PVC or concrete encased rigid galvanized steel.
 - 2. Under Slab on Grade: Schedule 40 PVC.
 - 3. Outdoor Locations, Above Grade: Rigid galvanized steel.
 - 4. Wet and Damp Locations: Rigid galvanized steel.
 - 5. Exposed or Concealed Dry Locations, Indoors: EMT, IMC, or rigid galvanized steel.
 - 6. All underground electrical wire, 208 volts or greater shall be in red concrete two (2) inches thick on all sides. Encasement not required under building slabs, parking lots or other paved surfaces. Red dye may not be applied to the top of the concrete.
 - 7. Transformers and Motors: 24 inch flexible metal conduit to equipment.
 - 8. Kitchens and outdoor motor and transformer connections: Liquidtight flexible metal conduit for all exposed raceway.
 - 9. Cooling Towers: PVC coated rigid galvanized steel within 50 feet of tower.

3.6 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings and as approved by the Architect.
- B. Adjust box location up to ten (10) feet prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 126 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Do not fasten boxes to ceiling support wires or other piping systems.
- G. Support boxes independently of conduit. Provide rigid support to structure for all junction boxes. Mount junction boxes within 18" of finished ceilings to facilitate future access. Locate junction boxes to allow ready access to junction box covers without removing any equipment.
- H. All outdoor boxes and/or boxes installed in exterior wall that penetrates building envelope

shall be UL listed for wet location service. Boxes shall be sealed to prevent air and water infiltration through the building envelope.

- I. Provide rigid support to structure for all junction boxes.
- J. Provide rigid support to structure for all conduit within 3 feet of each junction box and a maximum spacing of 10 feet.
- K. Install junction boxes above ceilings in accessible location with no obstructions. Locate within 18 inches of finished ceiling to facilitate easy access.
- L. For all flexible whips to light fixtures provide wire support at mid-length of whip to structure above with UL listed conduit support clip.
- M. Provide outlet boxes to meet depth requirement of Architectural walls. Refer to Architectural Spec Section 09250 and 10611 for wall partitions.

3.7 ADJUSTING

- A. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

3.9 INSTALLATION - FLOOR BOXES

- A. Use cast floor boxes for installation in slab on grade.
- B. Set floor boxes level.
- C. Install boxes and fittings to preserve fire resistant rating of slabs and other elements, using materials and methods specified in Section 26 05 29. Boxes shall be sealed to prevent air and water infiltration through the building envelope.

3.10 ADJUSTING

- A. Adjust floor box flush with finish material.

3.11 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.

3.11 ABOVE CEILING JUNCTION BOXES

- A. Labeling: Provide label on all above ceiling junction boxes.
 - 1. Provide permanent labeling with indelible black marker, in neat, legible print indicating the panelboard name, branch circuit number(s) and voltage of conductors within the junction box. Junction boxes used for emergency power circuits to be painted red.

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Underground Warning Tape.
 - 3. Lockout Devices.

1.2 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical identification, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and standards: Comply with the following:
 - 1. National Electrical Code, NFPA No. 70.
 - 2. NEMA standards applicable to the product provided.
 - 3. UL standards applicable to the product provided.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:
 - 1. Panduit Corp.
 - 2. American Labelmark Co.
 - 3. Markal Corp.
 - 4. Calpico, Inc.
 - 5. Ideal Industries, Inc.

2.2 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- B. Emergency Power panels and Equipment: Laminated three-layer plastic with engraved white letters on **RED** background.
- C. Letter Size:
 - 1. 1/4 inch high letters for identifying individual equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.3 UNDERGROUND WARNING TAPE

- A. Description: four (4) inch wide plastic tape, colored red with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 4. Secure nameplate to equipment front using screws, rivets, or adhesive.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 6. Install nameplates for the following:
 - a. Switchboards
 - b. Panelboards
 - c. Transformers
 - d. Service Disconnects
 - 1) Enclosed Switches
 - e. Motor Control Centers
 - f. Stand-alone Motor Controllers
 - g. Generators
 - h. Contactors
- C. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable six (6) to eight (8) inches below finished grade, directly above buried conduit, raceway, or cable. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
 2. Install line marker for underground wiring, both direct buried and in raceway.
- D. Printed Panelboard Directory:
1. Provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker for that panel.
 2. Copy in Owner's Manual.

3.3 ABOVE CEILING JUNCTION BOXES

- A. Labeling: Provide label on all above ceiling junction boxes.
1. Provide permanent labeling with indelible black marker, in neat, legible print indicating the panelboard name, branch circuit number(s) and voltage of conductors within the junction box.

3.4 ARC FLASH WARNING LABEL

- A. Install ARC flash warning label on switchboards, panel boards and motor control centers, etc. requiring examination, adjustments, servicing or maintenance while energized shall be field marked to warn persons of arc flash hazards in accordance with 2017 NEC articles 110.16 and 110.21. Marking shall be located so as to be clearly visible to qualified persons before servicing or maintenance.

END OF SECTION 26 05 53

SECTION 26 09 23 - DIGITAL LIGHTING CONTROL SYSTEM

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section include:
 - 1. Digital Lighting Controllers
 - 2. Relay Panels
- B. Related Sections:
 - 1. Section 26 27 26 Wiring Devices
 - 2. Section 26 50 00 Interior Lighting

1.2 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)
- B. International Electrotechnical Commission (IEC) (www.iec.ch)
- C. International Organization for Standardization (ISO) (www.iso.ch):
- D. National Electrical Manufacturers Association (NEMA) (www.nema.org)
- E. WD1 (R2005) - General Color Requirements for Wiring Devices.
- F. Underwriters Laboratories, Inc. (UL) (www.ul.com):
 - 1. 20 – Plug Load Controls
 - 2. 508 – Industrial Controls
 - 3. 916 – Energy Management Equipment
 - 4. 924 – Emergency Lighting

1.3 SYSTEM DESCRIPTION AND OPERATION

- A. The Lighting Control and Automation system as defined under this section covers the following equipment:
 - 1. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 - 2. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 - 3. Digital Occupancy Sensors – Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 - 4. Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 - 5. Configuration Tools – Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.

6. Digital Lighting Management (DLM) segment network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control.
7. Network Bridge – Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
8. Programming and Configuration Software – Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.

Digital Lighting Management Relay Zone Controller –Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS).

1.4 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Shop drawings:
 1. Composite wiring diagram of each control circuit proposed to be installed.
 2. Show locations of digital devices, sensors, load controllers and switches for each area as indicated on the Construction Documents.
 3. Provide room/area details including all product used in space and sequence of operation for each room/area.
 4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
- C. Product Data: Submit manufacturer product data sheets, specifications, installation instructions, dimensions, size, voltage ratings and current ratings. Indicate that all equipment and devices are suitable for the proposed application.
- D. Short circuit current rating (SCCR) of equipment.
- E. U.L. Label.
- F. Electrical characteristics of equipment.
- G. Enclosure metal gauge and finish.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Minimum of (10) ten years in manufacturing of lighting controls.

1.6 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 1. Ambient temperature: 0° to 40° C (32° to 104° F).

2. Relative humidity: Maximum 90 percent, non-condensing.

1.7 WARRANTY

- A. Provide a five year limited manufacturer's warranty on all room control devices and panels.

1.8 CLOSEOUT SUBMITTALS

- A. Provide manuals as described in Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Controls:
 1. Watt Stopper, Inc.
 2. Eaton/Cooper Controls
 3. Hubbell Building Automation, Inc.
 4. Acuity Brands, Inc.
- B. Sensors/Devices
 1. Watt Stopper, Inc.
 2. Eaton/Cooper Controls
 3. Hubbell Building Automation, Inc.
 4. SensorSwitch, Inc., PLC Multipoint Inc.
- C. Basis of design: WattStopper Digital Lighting Management (DLM) System or approved equivalent listed above.
- D. Enclosure: Provide a NEMA 1 enclosure for all contactors located indoors. Provide NEMA 4X for those located outdoors and in wet areas.

2.2 DIGITAL LIGHTING CONTROLS:

- A. Furnish the Company's system which accommodates the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

2.3 DLM LOCAL NETWORK (Room Network)

- A. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
- B. Features of the DLM local network include:
 1. Plug n' Go™ automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 2. Push n' Learn™ configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.

3. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- C. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
- D. If manufacturer's pre-terminated Cat5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.
- E. WattStopper Product Number: LMRJ-Series

2.4 DIGITAL LOAD CONTROLLERS (ROOM CONTROLLERS)

- A. Digital controllers for lighting loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room controllers shall be provided to match the room lighting control requirements. It does not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications. The control units will include the following features:
 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Multiple room controllers connected together in a local network will automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.
 3. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 4. Each load shall at a minimum be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
 5. The polarity of each load output is reversible, via digital configuration, so that on is off and off is on.
 6. UL 2043 plenum rated
 7. Manual override and LED indication for each load
 8. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.
 9. Zero cross circuitry for each load
- B. On/Off Room Controllers includes:
 1. One or two relay configuration
 2. Efficient 150 mA switching power supply
 3. Three RJ-45 DLM local network ports with integral strain relief and dust cover
 4. WattStopper product numbers: LMRC-101, LMRC-102

- C. On/Off/Dimming enhanced Room Controllers includes:
1. Real time current monitoring
 2. Multiple relay configurations
 - a. One, two or three relays (LMRC-21x series)
 - b. One or two relays (LMRC-22x series)
 3. Efficient 250 mA switching power supply
 4. Four RJ-45 DLM local network ports with integral strain relief and dust cover
 5. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)
 - b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
 - c. The LED level indicators on bound dimming switches will utilize this new maximum and minimum trim.
 - d. Each dimming output channel can be independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.
 - e. Calibration and trim levels must be set per output channel.
 - f. Devices that set calibration or trim levels per controller are not acceptable.
 - g. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
 6. WattStopper product numbers: LMRC-211, LPMC-212, LPMC-213

2.5 DIGITAL WALL OR CEILING MOUNTED SENSOR

- A. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. One or two RJ-45 port(s) for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 8. Manual override of controlled loads.
 9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- C. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- D. Units shall not have any dip switches or potentiometers for field settings.
- E. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- F. WattStopper product numbers: LMDX, LMDC

2.6 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.
 - 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 - 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
 - 6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. Two RJ-45 ports for connection to DLM local network.
- C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- D. Switch attributes may be changed or selected using a wireless configuration tool:
 - 1. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependant; each button may be bound to multiple loads.
- E. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.7 HANDHELD AND COMPUTER CONFIGURATION TOOLS

- A. A wireless configuration tool facilitates optional customization of DLM local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include but not be limited to:
 - 1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 - 2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.

3. Must be able to read and modify parameters for load controllers and relay panels, occupancy sensors, wall switches, daylighting sensors, network bridges, and identify DLM devices by type and serial number.
4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.
7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.
8. Verify status of building level network devices.

C. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.8 DLM SEGMENT NETWORK (Room to room network)

- A. The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and DLM zone controller for centralized control.
1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
 3. The segment network shall utilize 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 4. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
 5. Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
 6. Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-ROUTERS, via BACnet/IP or BACnet/Ethernet. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable.

B. WattStopper Product Number: LM-MSTP

2.9 NETWORK BRIDGE

- A. The network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
1. The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.

2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

B. WattStopper product numbers: LMBC-300

2.10 LIGHTING ZONE CONTROLLER

A. HARDWARE:

Provide LMCP lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

1. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
 - a. The LMZC shall use the same intelligence board as the LMCP relay panel.
 - b. The LMZC shall not include relay driver boards or relays.
 - c. The LMZC shall have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. The LMZC tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
 - e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
2. WattStopper Product Number Zone Controller: LMZC-301.

B. USER INTERFACE

Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following panel-specific functions as a minimum:

1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven

- day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
 6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.
 7. WattStopper Product Number: LMCT-100

2.11 PHOTO-ELECTRIC CONTROLS:

- A. Description:
1. General: Photo-electric control shall switch load ON at dusk and OFF at dawn.
 2. Housing: Photocell shall be enclosed in a weatherproof, corrosion resistant housing. The housing shall have a 1/2 inch I.P.S. nipple with a locking washer.
 3. Element: Light sensing element shall be Cadmium-Sulfide cell hermetically sealed against moisture. Minimum time delay before change-of-state shall be 15 seconds. If the photo-electric control fails, the load shall switch ON (fail-safe ON).
 4. Adjustment: The housing shall have an adjustable slide shield to vary the ambient light reaching the CdS cell. The slide shield shall not override the control; that is, the ON/OFF function shall occur even when the shield is at either extreme of the adjustment range. Adjustment shall be made by hand without tools.
 5. Temperature: The photocell shall be suitable for operation in an ambient temperature range of -30 degrees Fahrenheit to + 140 degrees Fahrenheit.
 6. Voltage: The photocell shall be suitable for use at voltage equal to the load voltage (120, 208, 277).
 7. Capacity: Photocell shall be SPST rated for a minimum of 1800 Volt-Amps resistive or inductive load.
 8. Leads: Photocell shall have minimum six (6) inch wire leads with wet location insulation. Leads shall be color coded Red/Load, Black/Line and White/Neutral.
 9. Listing: Photocell shall be listed by Underwriters Laboratories.
- B. Manufacturer: Intermatic, Paragon, Precision, Tork.

PART 3 – EXECUTION

3.1 PRE-INSTALLATION MEETING:

- A. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
1. Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
 2. Review the specifications for low voltage control wiring and termination.
 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 4. Discuss requirements for integration with other trades.

3.2 CONTRACTOR INSTALLATION AND SERVICES

- A. Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.
- B. Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- C. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.

3.3 FACTORY SERVICES

- A. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date.
- C. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.4 EXAMINATION

- A. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
- B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

3.5 INSTALLATION

- A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
- B. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.

- C. Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.

3.6 PHOTO-ELECTRIC CONTROL MOUNTING:

- A. Provide photo-electric control on roof of building. When more than one building is constructed on site, install photo control on each roof. Aim true North and locate in places where ambient night lighting will not cause interference. Wire down to respective contactors in each building.

3.7 SENSOR INSTALLATION

- A. Adjust sensitivity to cover area installed
- B. Set time delay on occupancy sensors that are connect to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.
- C. Sensor shall be powered through Input Module. No external power packs shall be used for powering sensors.
- D. Install occupancy sensors on vibration free stable surface.
- E. Install interior light sensor in ceiling facing the floor.

3.8 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
- B. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.9 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing wall stations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 09 23

SECTION 26 20 00 - ENCLOSED SWITCHES, ENCLOSED CIRCUIT BREAKERS AND MOTOR CONTROLLERS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Conditions of the Contract Documents and Division 1 - General Requirements as applicable, apply to this Section.

1.2 SUMMARY

- A. Provide all electrical distribution and motor control equipment and accessories required to distribute electrical power to all motors, outlets and systems requiring power.

1.3 QUALITY ASSURANCE

- A. New: Provide all new equipment.
- B. Single Manufacturer: All equipment of each type shall be the product of one manufacturer.
- C. UL: Equipment shall be UL listed. Service entrance equipment shall bear UL Service Entrance label.
- D. NEC: Equipment and installation shall comply with the National Electrical Code.
- E. Wet Locations: Equipment and enclosures installed outdoors and in wet locations shall be approved for the purpose.
- F. IEEE: Institute of Electrical and Electronics Engineers Standard 1015-1997 (Blue Book) Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

1.4 LABELING

- A. Nameplates and labeling shall be provided in accordance with Section 26 05 53. All feeders shall be labeled at the feeder device.

1.5 FINISHES

- A. All equipment shall have a factory applied gray finish applied over a rust inhibiting treatment. Any items which have the finish marred shall be touched up or refinished to a new condition before final acceptance. This shall include, but shall not be limited to, sanding and properly removing rust or other contaminants and completely repainting equipment if damage is extensive. Overall acceptance is subject to approval of the Engineer.

1.6 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.

- B. Provide complete product data for each equipment type. Provide electric service studies when required.
- C. Submittal shall include written recommendation from manufacturer of settings for all electronic trip adjustment setting on all equipment furnished with adjustable trip settings. Contractor is responsible for adjusting all electronic trip settings per manufacturer recommendations.
- D. Electrical connections to all equipment furnished by any other division shall be coordinated with final approved equipment submittals from other divisions including but not limited to circuit breaker sizes, conduit sizes, wire sizes, fuse sizes, disconnect switch sizes and starter sizes that differ from those shown on the drawings prior to submitting Electrical Distribution Equipment submittal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Unless indicated otherwise, all equipment in this section shall be provided from a single manufacturer. The product designations listed are to establish a level of quality. Acceptable manufacturers are,
 - 1. Square D
 - 2. Siemens
 - 3. G.E.
 - 4. Eaton - Cutler-Hammer

2.2 ENCLOSED SWITCHES

- A. General: Provide heavy duty enclosed switches similar to Square D Class 3100 Type HD.
- B. Switch Interior:
 - 1. All switches shall have switch blades which are visible when the switch is OFF and the cover is open.
 - 2. Lugs shall be front removable and UL Listed for 75 degrees Celsius conductors.
 - 3. All current carrying parts shall be plated to resist corrosion.
 - 4. Switches shall have removable arc suppressors to facilitate easy access to line side lugs.
 - 5. Switches shall have provisions for a field installable electrical interlock.
- C. Switch Mechanism:
 - 1. Switch operating mechanism shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.
 - 2. The operating handle shall be an integral part of the box, not the cover.
 - 3. Provisions for padlocking the switch in the OFF position with at least three padlocks shall be provided.
 - 4. The handle position shall travel at least 90 degrees between OFF and ON positions to clearly distinguish and indicate handle position.
 - 5. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

- D. Switch Enclosures:
1. Switch covers shall be attached with welded pin-type hinges.
 2. The enclosure shall be finished with gray baked enamel paint which is electrodeposited on cleaned, phosphate pre-treated steel.
 3. The enclosure shall have ON and OFF markings stamped into the cover.
 4. The operating handle shall be provided with a dual colored, red/black position indication,
 5. All switches shall have provisions to accept up to three (3) 3/8 inch hasp padlocks to lock the operating handle in the OFF position.
 6. Tangential knockouts shall be provided to facilitate ease of conduit entry.
 7. Interior Dry Locations: Type NEMA-1.
 8. Exterior Locations: Type NEMA-3R.
 9. Pool equipment room, buffer and sanitizer rooms: Type NEMA-4X Stainless steel.
- E. Switch Ratings:
1. Switches shall be horsepower rated for ac and/or dc as indicated on the plans.
 2. The UL Listed short circuit current rating of the switches shall be 200,000 rms symmetrical amperes when used with or protected by Class J fuses.
 3. Non-Fusible: 10,000 rms symmetrical amps.
- F. Fuse Clips: NEMA FU 1, Class J fuses.

2.3 FRACTIONAL HORSEPOWER MANUAL MOTOR CONTROLLER

- A. Square D - Class 2510 Type F.
1. Description: NEMA ICS 2, ac general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light and toggle operator.
 2. Enclosures: ANSI / NEMA ICS 6, Type as indicated.

2.4 MAGNETIC MOTOR CONTROLLERS

- A. Square D - Class 8536 Type S.
1. Description: NEMA ICS 2, ac general-purpose Class A magnetic controller for induction motors rated in horsepower.
 2. Coil Operating Voltage: Provide as required to interface with controls system, including control power transformer.
 3. Coil: Be of encapsulated type.
 4. Poles: as indicated.
 5. Size: as indicated.
 6. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.
 7. Wiring: Straight-through wiring with all terminals clearly marked.
 8. Overload Relay: NEMA ICS.
 - a. Solid State: Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered. Provide phase loss, phase unbalance protection, permanent tamper guard, Trip Class 10 or 20 and a mechanical test function.
 - b. Outputs: Units shall be designed for addition of either a normally open or normally closed auxiliary contact and shall be field convertible. Provide one (1) set of N.O. and N.C. contacts in each starter.
 - c. Reset: Unit shall include both manual reset and remote reset using an external module.

- d. Select overload current setting based on the motor nameplate data of the actual motor to be protected. All standard NEMA sizes may be used for the overload relay, including Size 00.
- 9. Enclosure: ANSI / NEMA ICS 6, Type 1, 3R or 4X.
- 10. Control Power Transformers: 120 volt secondary. VA minimum, in each motor starter. Provide fused primary and secondary.
- 11. Provide red running pilot light and H-O-A switch.

2.5 MAGNETIC MOTOR CONTROLLERS - TWO - SPEED

- A. Square D - Class 8810 Type S.
 - 1. Description: Include integral time delay transition between FAST and SLOW speeds. Starters shall be electrically and mechanically interlocked to prohibit both starters being energized simultaneously.
 - 2. Coil operating voltage: Provide as required to interface with controls system, including control power transformer.
 - 3. Coil: Be of encapsulated type.
 - 4. Poles: as indicated.
 - 5. Size: as indicated.
 - 6. Contacts: Totally enclosed, double-break, silver-cadmium-oxide power contacts.
 - 7. Contact inspection and replacement shall be possible without disturbing line or load wiring.
 - 8. Wiring: Straight-through wiring with all terminals clearly marked.
 - 9. Overload Relay: NEMA ICS.
 - a. Solid State; Trip current rating will be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered. Provide phase loss, phase unbalance protection, permanent tamper guard, Trip Class 10 or 20 and a mechanical test function.
 - b. Outputs: Units shall be designed for addition of either a normally open or normally closed auxiliary contact and shall be field convertible. Provide one (1) set of N.O. and N.C. contacts in each starter.
 - c. Reset: Unit shall include both manual reset and remote reset using an external module.
 - d. Select overload current setting based on the motor nameplate data of the actual motor to be protected. All standard NEMA sizes may be used for the overload relay, including Size 00.
 - 10. Enclosure: ANSI / NEMA ICS 6, Type 1, 3R or 4X.
 - 11. Two speed motor controllers shall be designed for type of motor winding specified in Division 23 Mechanical Specifications, Drawings, or Equipment Schedule. Coordinate with Division 23 prior to submittal.
 - 12. Provide red-high, amber-low running pilot lights and H-O-L-A switch.
 - 13. Provide two speed motor controllers for all two speed motors specified in Division 23 Mechanical Specifications, Drawings, or Equipment Schedule. Coordinate with Division 23 prior to submittal.

2.6 FUSES (600 VOLTS AND BELOW)

- A. Manufacturers:
 - 1. Bussmann.
 - 2. Little Fuse
 - 3. Ferraz Shawmut
- B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.

- D. Class J (Time Delay) Fuses
 - 1. Dimensions and Performance: NEMA FU 1.
 - 2. Voltage: Rating suitable for circuit phase-to-phase voltage.
 - 3. Dual-element, time delay ten (10) seconds (minimum) at 500 percent rated current.
- E. Spares: Spare fuses shall be provided in the amount of ten (10) percent of each type and size installed. Replacement for fuses and limiters blown during construction shall not count as spares.

PART 3 - EXECUTION

3.1 MOUNTING:

- A. General: All equipment shall be securely fastened in place.
- B. Locations: In all cases mounting locations shall comply with the requirements of the National Electrical Code. This shall include providing suitable working clearances.
- C. Concrete Pads:
 - 1. Provide concrete in accordance with the Division of the Specifications for that product.
 - 2. Indoor concrete pads shall consist of a four (4) inch pad with beveled edges extending two (2) inches beyond the perimeter of supported equipment. Switchboards, motor control centers, transformers greater than 15 KVA, and engine generators shall be installed on a pad. Refer to the drawings and the specifications for each piece of equipment to determine what other equipment shall be mounted on a pad.
 - 3. All equipment, ground mounted outdoors, shall be mounted on a pad. Outdoor pads shall be minimum of one foot thick reinforced with #4 rebar one (1) foot on center each way. Size outdoor pads with at least four (4) feet working clearance in front of equipment and one (1) foot on all sides. Provide anchor bolts for pad-mounted equipment. Refer to Detail on drawings.
- D. Wall Mounted Equipment: Wall mounted equipment shall be suitably positioned on the wall. Equipment mounted on exterior basement wall shall have unistrut channels between the wall and the equipment to prevent condensation problems. Where wall mounted equipment is specified, but a convenient wall not available, a suitable unistrut mounting stanchion anchored in concrete shall be provided. In lieu of this stanchion, small devices may be mounted on to the equipment served if approved by the equipment manufacturer.
- E. Motor rated disconnects: Install disconnects in a vertical orientation with "off" in the down position.

3.2 DELIVERY, STORAGE AND HANDLING:

- A. General:
 - 1. Store all types of electrical power distribution equipment in a clean, heated building affording appropriate physical protection. Control access to prevent unauthorized tampering with the equipment. However, equipment may be stored in other inside or outside environments under approved conditions.
 - 2. Inspect equipment when received at Project site for shipping damage. Report as required by freight carrier to recover repair or replacement costs from the freight carrier in the event damage was sustained.
 - 3. Covers are required unless indoor, ventilated storage conditions exist. Canvas tarpaulins or the equivalent are preferred over other coverings because they provide

- better humidity control and enclosure scuff protection. Where exposed to moisture, covers shall be waterproof.
4. The manufacturer's shipping skids shall be left on the equipment to provide structural support until the equipment is set in final resting place.
 5. Refer to Section 26 05 00 for additional requirements. Contractor shall furnish new equipment to replace any equipment that is exposed to weather or subjected to other deleterious effects of construction.
- B. Approved Conditions for Equipment Storage:
1. General: Where storage conditions specified above are not available, indoor or outdoor storage shall comply with the following.
 2. Switchboards, Motor Control and Other General Distribution and Utilization Equipment:
 - a. Store metal-enclosed equipment in the upright position. Provide good ventilation of the shelter and protection from dirt, moisture and physical damage.
 - b. Space heaters furnished with the equipment shall be connected to a continuous source of power of the proper rating. Where space heaters are supplied from auxiliary power transformers, care shall be taken that low-voltage heater circuits are properly isolated before power source connection to prevent inadvertent energizing of the auxiliary transformer and associated high-voltage primary wiring.
 - c. Ambient conditions may allow condensation inside waterproof covers. If condensation is occurring, temporary heaters or lamp banks shall be provided of sufficient wattage to prevent condensation.
 - d. Contractor shall ensure that equipment stored in shipping cases receives adequate ventilation to avoid mildew and prevent condensation.
- C. Transformer
1. Indoor storage shall be provided for all transformers.

3.3 GROUND FAULT PROTECTION OF EQUIPMENT:

- A. General: Provide for system performance testing as required by the National Electrical Code. Provide each ground fault relay, sensing device or ground fault protection system with instructions and a test form. The form shall be retained by those in charge of the building's electrical installation and be available to the authority having jurisdiction. The instruction content shall be as required by UL.

3.4 LABELING:

- A. Nametag: Provide a nametag for each piece of distribution equipment; see Section 16075, Electrical Identification.

END OF SECTION 26 20 00

SECTION 26 22 00 - LOW VOLTAGE TRANSFORMERS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - A. Distribution transformers.
 - B. Buck-boost transformers.

1.3 ACTION SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - A. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - A. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

- B. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.
- D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - A. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Manufacturers: Firms regularly engaged in the manufacture of power distribution transformers of types and ratings required, whose products have been in satisfactory use in similar service for not less than five (20) years.
- D. Installer: Qualified with at least three (5) years successful installation experience on projects with electrical power/distribution transformer work similar to that required for this project.
- E. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 REFERENCES

- A. NEC Compliance: Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.

- B. NEMA Compliance: Comply with applicable portions of the NEMA Std. Pub. Nos. TR1 and TR27 pertaining to power/distribution transformers.
- C. ANSI Compliance: Comply with applicable ANSI standards pertaining to power/distribution transformers.
- D. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers.
- E. ANSI/NEMA Compliance: Comply with NEMA Std. ST 20 "Dry-Type Transformers for General Applications".
- F. ANSI/UL Compliance: Comply with applicable portions of ANSI/UL 506 "Safety Standard for Specialty Transformers".
- G. UL Labels: Provide distribution transformers that have been UL listed and labeled.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - A. Eaton Electrical Inc.; Cutler-Hammer Products.
 - B. General Electric Company.
 - C. Siemens Energy & Automation, Inc.
 - D. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - A. Internal Coil Connections: Brazed or pressure type.
 - B. Coil Material: **Copper**.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: **Ventilated** NEMA 250, Type 2.
 - A. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Enclosure: **Ventilated** NEMA 250, **Type 3R**.
 - A. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 - A. Finish Color: **Gray**.
- G. Taps for Transformers 25 kVA and Larger: **Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity**.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of **115 deg C** rise above 40 deg C ambient temperature.

I. Energy Efficiency for LV Dry Type Transformers:

A. Complying with DOE 10 CFR 431 – 2016 Energy Efficiency Standard as follows:

| Single-Phase | | | |
|--------------|----------------|----------|---------|
| KVA | BIL Efficiency | | |
| | 20-45 kV | 46-95 kV | ≥ 90 kV |
| | % | | |
| 15 | 98.10 | 97.86 | - |
| 25 | 98.33 | 98.12 | - |
| 37.50 | 98.49 | 98.30 | - |
| 50 | 98.60 | 98.42 | - |
| 75 | 98.73 | 98.57 | 98.53 |
| 100 | 98.82 | 98.67 | 98.63 |
| 167 | 98.96 | 98.83 | 98.80 |
| 250 | 99.07 | 98.95 | 98.91 |
| 333 | 99.14 | 99.03 | 98.99 |
| 500 | 99.22 | 99.12 | 99.09 |
| 667 | 99.27 | 99.18 | 99.15 |
| 833 | 99.31 | 99.23 | 99.20 |

| Three-Phase | | | |
|-------------|----------------|----------|---------|
| KVA | BIL Efficiency | | |
| | 20-46 kV | 46-95 kV | ≥ 90 kV |
| | % | | |
| 15 | 97.50 | 97.18 | - |
| 30 | 97.90 | 97.63 | - |
| 45 | 98.10 | 97.86 | - |
| 75 | 98.33 | 98.13 | - |
| 112.50 | 98.52 | 98.36 | - |
| 150 | 98.65 | 98.51 | - |
| 225 | 98.82 | 98.69 | 98.57 |
| 300 | 98.93 | 98.81 | 98.69 |
| 500 | 99.09 | 98.99 | 98.89 |
| 750 | 99.21 | 99.12 | 99.02 |
| 1000 | 99.28 | 99.20 | 99.11 |
| 1500 | 99.37 | 99.30 | 99.21 |
| 2000 | 99.43 | 99.36 | 99.28 |
| 2500 | 99.47 | 99.41 | 99.33 |

B. Tested according to NEMA TP 2.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

- A. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
- B. Indicate value of K-factor on transformer nameplate.

LOW-VOLTAGE TRANSFORMERS

- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - A. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - B. Include special terminal for grounding the shield.
 - C. Shield Effectiveness:
 - a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
 - b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
 - c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
- O. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
 - A. 9 kVA and Less: 40 dBA.
 - B. 30 to 50 kVA: 45dBA.
 - C. 51 to 150 kVA: 50dBA.
 - D. 151 to 300 kVA: 55dBA.
 - E. 301 to 500 kVA: 60dBA.
 - F. 501 to 750 kVA: 62dBA.
 - G. 751 to 1000 kVA: 64dBA

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each **distribution** transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - A. Brace wall-mounting transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, **seismic codes applicable to Project**, and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Retain one of three paragraphs below that identify who shall perform tests and inspections. If retaining second option in first paragraph, or if retaining second or third paragraph, retain requirement for field quality-control test reports in "Informational Submittals" Article.
- B. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

- D. Perform tests and inspections and prepare test reports.
 - A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- E. Tests and Inspections:
 - A. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- F. Remove and replace units that do not pass tests or inspections and retest as specified above.
- G. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - A. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - B. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
 - C. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- H. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 TRANSFORMER VIBRATION ISOLATION:

- A. Floor Mounted Transformers: Install on concrete housekeeping pad with Mason Industries Type WM Neoprene Waffle pad, or equal. Provide Type WM isolation for elevated rack installation.
- B. Floor Mounted Transformers Greater than 150 kVA: Install on Mason Industries, Inc, or equal, unhoused spring isolators with acoustical pad bonded to bottom. Isolators shall be undamped free-standing spring isolators sized for a minimum of two (2) inches of static deflection. The spring outside diameter shall be no less than 80 percent of the spring operating height. The spring shall have remaining travel to solid of no less than 50 percent of the static deflection. Provide a 1/4 inch neoprene friction pad bonded to the spring base. Bolt each vibration isolator unit to concrete pad, and bolt transformers to the vibration isolator units, using the leveling bolts and nuts provided with the unit.

3.6 TRANSFORMER VENTILATION:

- A. Transformers with ventilating openings shall be installed so that the ventilating openings are not blocked by walls or other obstructions. The required clearances shall be clearly marked on the transformer.

3.7 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.8 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

SECTION 26 24 16 - ELECTRICAL PANELBOARDS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 specification sections, apply to the work of this Section.
- B This Section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK

- A Extent of panelboard and enclosure work, including cabinets and cutout boxes is indicated on the drawings and by schedules.
- B Types of panelboards and enclosures in this Section include the following:
 - 1. Distribution Panels
 - 2. Lighting and Appliance Panels
- C Refer to other Division 26 sections for cable/wire, connectors and electric raceway work required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

- A Manufacturers: Firms regularly engaged in the manufacture of panelboards and enclosures, of types, size and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B Installer: A firm of at least three (3) years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

- A Special Use Markings: Provide panelboards, constructed for special use, with UL markings indicating that special type usage. Panels identified or shown on the drawings for use as main service entrance equipment shall be labeled at the factory with "SERVICE ENTRANCE" type UL label.
- B UL Compliance: Comply with applicable UL safety standards pertaining to panelboards, accessories, and enclosures. Provide units which have been UL listed and labeled. UL standards are as follows:
 - 1. Panelboards - UL67
 - 2. Cabinets and Boxes - UL50
- C NEC Compliance: Comply with the NEC as applicable to the installation of panelboards, cabinets, and cutout boxes.

- D NEMA Compliance: Comply with NEMA Stds. Pub. No. 250 "Enclosures for Electrical Equipment (1000 volt maximum)", Pub. No. 1 "Panelboards" and Pub. No. PB1.1, "Instruction for Safe Installation, Operation, and Maintenance of Panelboards Rates 600 Volts and Less".
- E NECA Compliance: Comply with NECA's "Standard of Installation".

1.5 SUBMITTALS

- A Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each panelboard required. Include data substantiating that units comply with specified requirements.
- C Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not limited to circuit breakers, fusible switches, fuses, ground fault circuit interrupters, and accessories.

1.6 SHORT CIRCUIT CURRENT RATINGS

- A. General: All switchboards and panelboards shall be fully rated and marked with a maximum short circuit current rating unless otherwise noted. The equipment manufacturer shall have verified this rating with high-amperage testing. All short circuit current ratings are expressed as amperes RMS symmetrical at the applied voltage unless otherwise noted. All equipment shall withstand the specified level of fault current. All overcurrent devices shall interrupt the specified level of fault current.

PART 2 - PRODUCTS

- 2.1 ACCEPTABLE MANUFACTURERS:** Subject to compliance with requirements provide products of one of the following:

- a. Eaton - Cutler Hammer
- b. General Electric Corp.
- c. Square D Company
- d. Siemens

2.2 GENERAL

- A Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, and which are designed and constructed in accordance with published product information. Provide solderless lugs, or connectors, in the correct number and size for conductors on mains, on the load side of each branch, circuit, and on ground and neutral bars. Provide tin plated copper busses. Provide an insulated neutral bus (equal in size to the phase bussing) and a bonded equipment ground bus mounted at the opposite end of the structure from the mains, and having numbered screw or lug terminals for connection of wires. Equip panels with the number of unit devices as required for a complete installation. Where more than one

- type of component meets the indicated requirements, selection is installer's option. Where types, sizes or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.
- B Provide ground fault circuit interrupting type circuit breakers for all devices noted with a "GFI" subscript on the panelboard schedules for this project.
 - C Provide UL listed HACR type circuit breakers for all devices which serve heating, ventilating, or air conditioning equipment.
 - D Panelboards shall be provided with covers for surface or flush mounting as shown on the drawings, or as required for actual project conditions.
 - E Panelboards shall be constructed for top or bottom feeder service, as required by actual project conditions.
 - F All panels shall be marked with PPE level per NEC where fault current calculations have been done.

2.3 LIGHTING AND APPLIANCE PANELS

- A Lighting and appliance panelboards shall be Square D type NQOD, class 1630 (or equal) for 277/480 volt or 120/208 volt applications. All branch circuit breakers are to be quick-make, quick-break, trip indicating and common trip on all multi-pole breakers, and shall be bolt-on type. Trip indication shall be clearly shown by breaker handle located between the "ON" and the "OFF" positions. Panelboards shall have distributed phase copper bussing throughout.
- B Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard
- C Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard;
- D For non-linear load applications subject to harmonics furnish 173 percent rated, plated copper, solid neutral.
- E Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 208-240/120 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards.
- F Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits,
- G Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.
- H Enclosure: NEMA PB 1, Type 1 or Type 3R.
- I Cabinet Front: Safety dead front type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.
- J Provide ground-fault circuit breaker for each heat trace branch circuit.
- K Panelboards indicated to have thru-feed lugs shall be furnished with thru-feed lugs in all sections of panelboard.

- L Provide fully rated main circuit breaker type panelboards, where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings. The Contractor may, at his option, (if acceptable to the local Code Authority) provide main circuit breaker type panelboards where the short circuit rating of the complete panelboard is determined by the use of UL approved combinations of main and branch circuit breaker devices, and the rating of the complete panelboard assembly is as shown on the drawings.
- M Provide fully rated main lug only type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings. The Contractor may, at his option, (if acceptable to the local Code Authority) provide main lug only type panelboards where the short circuit rating of the complete panelboard assembly is determined by the use of UL approved combinations of upstream devices and branch circuit breaker devices, and the rating of the complete panelboard assembly is as shown on the drawings.
- N Panelboard boxes shall have 6-inch minimum gutters. Fronts are to be complete with door and cylinder lock, with all locks keyed alike. Fronts shall have adjustable trim clamps, directory frames, and shall be equipped with a typewritten directory that identifies each circuit breaker by number and the equipment that the breaker serves. One additional blank directory card for each panel shall be furnished to the Owner.
- O Panelboards shall be Underwriters' Laboratory listed and shall bear the UL label. The size of the panelboard main disconnect device or main lugs, the rating and number of branch circuits, and the type of mounting shall be as shown on the drawings.
- P All factory installed devices shall be re-torqued prior to energizing.

2.4 DISTRIBUTION PANELS

NOTE TO SPECIFIER: THIS SPECIFICATION IS FOR CIRCUIT BREAKER TYPE DISTRIBUTION PANELS.

Distribution panels shall be Square D I-Line Series (or equal) panels as indicated on the plans. Provide appropriate type of panels to meet specific project requirements. Panelboards shall have distributed phase copper bussing throughout.

- A Product Description: NEMA PB 1, circuit breaker type panelboard.
- B Panelboard Bus: copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
- C Continuous current rating shall be sufficient to protect wiring and equipment served.
 - 1. Panels 400A and smaller, 35,000 amperes rms symmetrical.
 - 2. Panels greater than 400A: 65,000 amperes rms symmetrical.
- D Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits. Breakers shall be 100% fully rated.

- E Main Circuit Breaker:
1. When distribution panel has main circuit breaker, provide molded case circuit breaker with electronic trip unit. Current sensing to be true-rms. 100% fully rated.
 2. Main breaker shall have minimum interrupting rating of 65,000 amperes rms symmetrical at applied voltage.
 3. Electronic trip shall be Square D micrologic with adjustable long-time, short-time and instantaneous pick-up set points.
- F Cabinet Front: Safety dead front type. Conform to NEMA 1; NEMA 3R if located outdoors.
- G Circuit breakers shall be as specified for lighting panels unless indicated otherwise. Power panels shall have combination card holder and name-plate and shall be equipped with typewritten directories that identify all loads served and all spare circuits. Provide a copper ground bus in all power panel.
- H Power panels shall be Underwriters' Laboratory approved and shall bear the UL label. Main lugs and gutters shall be suitable for copper and aluminum wire. The size of the panelboard main protective device or main lugs, the size, type and the number of branch circuits and the type of mounting shall be as shown on the drawings.
1. Provide fully rated main circuit breaker type panelboards, where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings. The Contractor may, at his option, (if acceptable to the local Code Authority) provide main circuit breaker type panelboards where the short circuit rating of the complete panelboard is determined by the use of UL approved combinations of main and branch circuit breaker devices, and the rating of the complete panelboard assembly is as shown on the drawings.
 2. Provide fully rated main lug only type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings. The Contractor may, at his option, (if acceptable to the local Code Authority) provide main lug only type panelboards where the short circuit rating of the complete panelboard assembly is determined by the use of UL approved combinations of upstream devices and branch circuit breaker devices, and the rating of the complete panelboard assembly is as shown on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A General: Install panelboards and enclosures where indicated, in accordance with the manufacturers' written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B Coordinate the installation of panelboards and enclosures with cable and raceway installation work.
- C Provide all required electrical connections within the enclosure.
- D Fill out typewritten panelboard circuit directory cards upon completion of the installation work.

END OF SECTION 26 24 26

SECTION 26 27 26 - WIRING DEVICES

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wall switches; wall dimmers; receptacles; device plates and box covers. All devices shall be installed in outlet boxes of required size and volume.

1.2 DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry, but not utilize electrical energy.
- C. Types of electrical wiring devices in this Section include the following:
 - 1. Receptacles
 - 2. Occupancy Sensors
 - 3. Switches
 - 4. Wall Plates
 - 5. Dimmer Controls

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of wiring devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: Qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices. Standards WD-1 and WD-6.
- D. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Submit manufactures product data for all wiring devices intended to be used on project, indicate intended color and cover plate. Final color selections to be made by Architect.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All devices shall be suitable for use intended, and have voltage and current ratings adequate for loads being served.

2.2 Manufacturers: Subject to compliance with requirements, provide products of one of the following:

- A. Pass and Seymour Corporation
- B. Cooper
- C. Hubbell, Inc.
- D. Leviton, Inc.
- E. Crouse Hinds
- F. Wiremold
- G. Lutron

2.3 WALL SWITCHES

- A. Single Pole Switch, Toggle Style:
 - 1. Leviton 1221 Series, 20A, 120/277V.
- B. Double Pole Switch, Toggle Style:
 - 1. Leviton 1222 or 3032 Series, 20A or 30A, 120/277V.
- C. Three-way Switch, Toggle Style:
 - 1. Leviton 1223 Series, 20A, 120/277V.
- D. Four-way Switch, Toggle Style:
 - 1. Leviton 1224 Series, 20A, 120/277V.
- E. Indicator Switch, Toggle Style:
 - 1. Leviton 1201 Series, 20A, 120/277V. Switch illuminated when load is on.
- F. Locator Switch, Toggle Style:
 - 1. Leviton 1221 Series, 20A, 120/277V. Switch illuminated when load is off.
- G. Digital Time Switch:
 - 1. Wattstopper TS-400 digital time switch with optional visual warning to flash lights at 5 minutes and 1 minute prior to time-out.
- H. Key lock switches:
 - 1. Provide key lock switches for corridor lighting and other locations indicated on electrical drawings.
 - 2. 20 Amp rated.
 - 3. 120/277 Volt ac rated.
 - 4. Key-lock mechanism can only be turned ON or OFF with key.
 - 5. Single pole: Leviton 1221-2KL or approved equal.

6. 3-Way: Leviton 1223-2kl or approved equal.
7. 4-Way: Leviton 1224-2kl or approved equal.
8. Provide 302 stainless steel wall plate for each switch.
9. Provide 2 keys on ring for each switch.
10. Include a brass tag on every key switch ring. Engrave tag; Example: "Hall East Lights".
11. Key all switches alike to match the owners standard key. Coordinate with School District for key match.

I. Color: As selected by Architect.

2.4 OVERRIDE SWITCH

- A. The manual override switch shall override the time switch or time clock controlling the interior lighting to allow not more than 2 hours of afterhours use in accordance with latest IECC requirements.
- B. Override switch shall be located at a common entry point. See lighting drawings for location(s).

2.5 MOTOR RATED SWITCHES

- A. Provide where a switch is indicated as a local disconnect for all mechanical and plumbing equipment.
- B. Leviton MS Series.

2.6 WALL DIMMERS

- A. Manufacturers:
 1. Lutron Vareo Series.
- B. Product Description: Tap ON-OFF switch with side slide dimmer switch. Coordinate switch with lighting load interface requirements per manufacturer recommendations.
- C. Body and Handle: Linear slide handle, color as selected by Architect.
- D. Voltage: 120/277 volts rated.

2.7 RECEPTACLES

- A. Single Convenience Receptacle:
 1. Leviton 5361 Series, 20A/125V.
- B. Duplex Convenience Receptacle:
 1. Leviton 5362 Series, 20A/125V.
- C. GFCI Receptacle:
 1. Leviton 7899 Series, 20A/125V.
 2. Provide GFCI receptacles for all receptacles on 120v circuits installed in kitchens, restrooms and outdoors (including rooftops).

- D. TAMPER-RESISTANT RECEPTACLES
1. Tamper-Resistant Convenience and Straight-blade Receptacles: Tamper-resistant receptacles shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with a separate green ground screw. Receptacles shall be as follows:
Hubbell 8300*TR,
Leviton 5362-SG*
Pass & Seymour TR5362*, or approved equal. (* indicates color selection).
- E. TAMPER-RESISTANT GFCI RECEPTACLE;
1. Tamper-Resistant duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class A. Receptacles shall be as follows:
Hubbell GFR5362*TR
Leviton X7899-*
Pass & Seymour 2095TR*, or approved equal. (* indicates color selection).
- F. All devices shall be rated for a minimum of 20A unless otherwise noted. Provide 20 amp receptacles for single-receptacle branch circuits.
- G. For locations where a quadruplex or fourplex is required, provide 2-duplex receptacles under common cover plate.
- H. Color:
1. For general purpose receptacles color shall be as selected by Architect.
 2. For receptacles on emergency power and/or life safety power color shall be RED.
 3. For isolated ground receptacles color shall be ORANGE with GREEN triangle.
 4. For receptacles on UPS power color shall be BLACK or color as determined by Owner.

2.8 OCCUPANCY SENSORS

- A. General Requirements:
1. All occupancy sensors shall be line voltage hardwired type; battery type shall not be permitted. Low voltage sensors with power packs shall be allowed in area with an accessible and where indicated on the drawings.
 2. Sensors shall use dual technology, passive infrared and passive acoustic sensing or passive infrared and ultrasonic sensing for detecting room occupancy.
 3. Sensitivity shall be user adjustable or self-adjusting type.
 4. The delay timer shall be adjusted within a range of 6 to 30 minutes by the contractor in the field. The sensor shall have a test mode for performance testing.
 5. The test LED shall indicate motion.
 6. Line voltage sensors are acceptable, especially in exposed ceiling areas where all wiring shall be installed in conduit, including low voltage cabling if power packs are used. Provide power pack as required for low voltage sensors.
 7. See drawings for actual types of sensors.
 8. Occupancy sensors and power packs shall have five year warranties.

B Wall Mounted (Wall Switch Type):

1. The unit shall fit in/on a standard single gang switch box.
2. Rated capacity: 600 watts minimum at 120 volts, 60 Hz; 1000 watts minimum at 277 volts, 60 Hz.
3. The sensor shall have two switches where dual-level lighting is required. The switch shall have manual override for positive OFF and automatic ON.
4. The area of coverage shall be approximately 180 degrees by 35-40 feet.

C Ceiling Mounted:

1. The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.
2. The coverage area shall be 360 degrees by approximately 15 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.

D Ceiling Mounted: Ceiling/Corner Mounted:

1. The unit shall fit in/on a standard octagon box. All ceiling mounted sensors shall be installed to a box with ring and box support.
2. The coverage area shall be 90 degrees or greater by approximately 40 feet radius when mounted at 9 foot height. The sensor shall have provisions, such as masking, to block out problem areas.

E Auxiliary Contacts for HVAC Interlock:

1. Provide auxiliary dry contacts for HVAC BAS interlock when required. Refer to the HVAC drawings for requirements. When required, provide auxiliary contacts regardless if the occupancy sensors are line or low voltage.
2. The occupancy sensors and auxiliary contacts shall be wired such that the sensor still detects occupancy and controls the auxiliary contacts regardless if the light switch(es) are in the OFF position (e.g. the occupant has turned the lights OFF because there is enough daylight, but the occupant is still occupying the space, and the occupancy sensor senses the occupant and closes the auxiliary contacts for BAS input).
3. The BAS wiring to the auxiliary contacts shall be by the Division 23 contractor.

2.9 WALL PLATES

- A. Type 302 Stainless Steel with matching mounting screws.

PART 3 - EXECUTION

3.1 EXISTING WORK

- A. Disconnect abandoned circuits and remove raceway, wire, and cable. Remove abandoned boxes when connecting wire and cable is abandoned and removed. Install blank cover for remaining abandoned boxes.
- B. Maintain access to existing boxes and wiring connections remaining active and requiring access.

- C. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

3.2 INSTALLATION

- A. Install wiring devices as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices and other work.
- C. Testing: Test wiring devices for electrical continuity and proper polarity of connections. Test wiring devices to demonstrate compliance with requirements.
- D. All outlets shall be located as shown on the drawings, except that where practicable; outlets shall be located in center of panels or trim or otherwise symmetrically located to conform with the structural layout. Outlets incorrectly installed shall be corrected. Damaged items or damaged finishes shall be repaired or replaced at no expense to the Owner.
- E. Outlets shall be set plumb or horizontal and shall extend to the finished surface of the walls, ceiling or floor, as the case may be, without projecting beyond the same.
- F. Outlets shall be installed with ground at top and in accordance with manufacturer's installation instructions.
- G. Receptacles, switches, etc., shown on wood trim, cases or other fixtures shall be installed symmetrically; and, where necessary, shall be set with the long dimensions of the plate horizontal, or ganged in tandem.
- H. Where dimmer switches are shown adjacent to standard switches, both shall be installed in separate back boxes with adequate space between so that neither cover plate requires cutting.
- I. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- J. Where devices are shown mounted adjacent to one another on the drawings, provide multi-gang faceplates to cover all devices.
- K. Route raceway and cable to meet Project conditions.
- L. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- M. Adjust box location up to ten (10) feet prior to rough-in when required to accommodate intended purpose.
- N. Do not install flush mounting box back-to-back in walls; install boxes with minimum 24 inches separation.
- O. Wet Locations: Wiring devices and their enclosures installed outdoors and in wet locations shall be approved for that purpose. Install "in-use" non-attended hinged cover for all receptacles installed outdoors.

- P. Minimum Raceway Size: 3/4 inch.
- Q. Occupancy Sensor Power packs used in return air plenum ceiling areas shall be UL listed for return air plenum.
- R. Provide a minimum of 12' of coiled cable for ceiling-mounted low voltage sensors with power packs.
- S. Occupancy sensors shall be installed at locations indicated on the manufacturer's submittal layout drawings. Sensors shall be located to prevent false "ON" tripping of the lights.
- T. Occupancy Sensor Sensitivity Test: After the sensor has been energized for at least 15 minutes, walk to the middle of the room (if conference room) or sit at the normal desk position (if an office). Make no motion for 20 seconds. Move one arm up and down slowly. The test LED should blink.
- U. Occupancy Sensor Time Delay Test: Set the time delay for 15 minutes. Walk into the room to activate the sensor then leave room. Sensor must turn lights off at approximately 15 minutes. Walk into the room again to reactivate the lights. Lights should activate within 1 second.

3.3 MOUNTING HEIGHTS

- A. As indicated on Drawings or if not indicated in accordance with the Architects instructions. All other telephone, Data, TV, etc. outlets shall be same as receptacle.

3.4 GANGED SWITCHES

- A. Install permanent barrier between all 277 Volt light switches ganged into one outlet box.
- B. Where multiple switches are grouped on one location, install switches under a one piece, multi-gang cover plate.
- C. Other telephone, data, TV, etc. outlets shall be same as receptacle.

3.5 GFCI

- A. Provide ground-fault circuit-interrupter type receptacles for all 15 and 20 amp receptacles shown on drawings in restrooms, kitchens and outdoors.
- B. All receptacles installed and within 6 feet of the outside edge of sinks shall be GFCI type.
- C. All receptacles installed in outdoor locations, garages, rooftops, and in other damp or wet locations shall be GFCI type with a weather-resistant (WR) rating.
- D. All outdoor receptacles shall be provided with a non-attended "in-use" cover. Cover shall ensure that device and plug are not exposed to the weather conditions when in use.

END OF SECTION 26 27 26

SECTION 26 33 23 - CENTRAL BATTERY/INVERTER SYSTEM

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

- A. This section provides technical information and specifications for a central lighting inverter system. Basis of design is Crucial Power Products Waverider 1.
- B. The unit shall feature high reliability solid-state double conversion digital signal processing and a high frequency pulse-width modulated (PWM) system that harnesses the advantages of IGBTs (Insulated-Gate Bipolar Transistor) in its design. The unit will provide high quality regulated and conditioned AC power to all types of lighting loads all of the time. It switches to battery power with virtually zero transfer time upon an input power loss or disruption.
- C. The unit shall meet UL 924 requirements for emergency lighting system applications and provides the security of 90-minutes of battery backup power. It is suitable for all lighting loads including any combination for electronic and security systems, power factor corrected self-ballast Fluorescent, Incandescent, quartz re-strike, halogen, HID, HPS and LED lighting during battery backup operation.
- D. The unit can be operated at 0 to 100% loading for a minimum of 90 minutes. Upon the restoration of power from the AC utility line, the system automatically returns to normal operation without any interruption of power to the load. The unit shall meet UL 924 requirements for recharging the battery while utilizing an industry distinctive small footprint for its stackable cabinet design. This allows equipment installation in limited spaces.

1.3 SUMMARY

- A. This Section includes **UPS** central battery inverters with the following features:
 - 1. Output distribution section.
 - 2. Internal maintenance bypass/isolation switch.
 - 3. External maintenance bypass/isolation switch.
 - 4. Multiple output voltages.
 - 5. Emergency-only circuits.
 - 6. Remote monitoring provisions.

1.4 STANDARDS:

- A. Unit shall comply with the following standards:
 - 1. CSA certified per UL1778

2. UL 924 and CSA 22.2 No. 107.1.
3. UL 924/UL 924A – Life Safety for Emergency Backup Lighting
4. FCC rules and regulations, Part 15, subpart j, class A
5. NEMA PE-1
6. NFPA 101 (Life safety code)
7. ANSI C62.41 (IEEE 587)
8. ANSI C62.42.45 (Cat. A and B)
9. SPD (UL1449 4TH Edition)

1.5 DEFINITIONS

- A. LCD: Liquid-crystal display.
- B. LED: Light-emitting diode.
- C. THD: Total harmonic distortion.
- D. UPS: Uninterruptible power supply.
- E. SPD: Surge Suppression Device

1.6 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: For the following:
 - 1. Electrical ratings, including the following:
 - a. Capacity to provide power during failure of normal ac.
 - b. Inverter voltage regulation and THD of output current.
 - c. Rectifier data.
 - d. Transfer time of transfer switch.
 - e. Data for specified optional features.
 - 2. Transfer switch.
 - 3. Inverter.
 - 4. Battery charger.
 - 5. Batteries.
 - 6. Battery monitoring.
 - 7. Battery-cycle warranty monitor.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 - 1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
 - 2. Elevation and details of control and indication displays.
 - 3. Output distribution section.

- D. **Manufacturer Seismic Qualification Certification:** Submit certification that central battery inverter equipment will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
 - 1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. **Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.**
- E. **Qualification Data:** For testing agency.
- F. **Source quality-control test reports.**
- G. **Field quality-control test reports.**
- H. **Operation and Maintenance Data:** For central battery inverter equipment to include in emergency, operation, and maintenance manuals.
- I. **Warranty:** Special warranty specified in this Section.

1.7 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** A minimum of twenty years experience in the design, manufacture and testing of solid-state UPS is required. The manufacturer shall specialize in manufacturing of online, double conversion, high frequency, UPS modules as specified in this document.
 - 1. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
- B. **Installer Qualifications:** Installer shall be a firm that shall have a minimum of ten years of successful installation experience with projects utilizing solid state UPS similar in type and scope to that required for this Project.
- C. **Materials and Assemblies:** All materials and parts in the UPS shall be new, of current manufacture and unused, except for the purpose of factory testing. All active electronic components shall be solid state and designed so as not to exceed the manufacturer's recommended ratings and tolerances for ensuring maximum reliability. All IGBTs and other semiconductor devices shall be sealed. All relays shall have dust covers. All incoming parts, modular assemblies and sheet metal shall undergo detailed receiving quality inspection.

- D. **Factory Testing:** Every unit shipped will have completed a documented functional test of the UPS module and battery system, including a battery discharge test. A copy of the test report shall be available at the customer's request.
- E. Testing Agency Qualifications: Member company of the International Electrical Testing Association or is an NRTL **acceptable to authorities having jurisdiction.**
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. Central Battery Inverter System: UL 924 **and UL 1778** listed.
- H. Comply with NFPA 70 and NFPA 101.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles.
- B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
 - 1. Warranty Period: Include the following warranty periods:
 - a. Battery:
 - 1) The battery manufacturer's standard warranty shall be transferred and assigned to the end user. It will have a minimum period of one (10) years.
 - b. Inverter:
 - 1) The inverter manufacturer shall warranty the inverter against defects in materials and workmanship for a period of twenty-four (24) months. The warranty shall cover all parts and labor for a one (1) year period beginning from the startup or 18 months from the ship date, whichever comes first. Optional 1-year extended warranty and maintenance contract packages shall also be available at the end of the factory maintenance period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Crucial Power Products Waverider 1 or a comparable product by one of the following:
 - 1. Crucial Power Products.

2. Myers Power Products
3. Hubbell Incorporated; Hubbell Lighting.

2.2 OPERATION

- A. The system shall utilize high frequency pulse width modulation and digital signal processing for control and monitoring. The system's automatic overload and short circuit protection of the inverter in normal and emergency operations shall have 150% momentary surge capability and withstand a 115% overload for 10 minutes. The system's protection shall also include a low battery voltage disconnect to prevent damage to the battery bank. The system shall supply a clean, computer grade, sinusoidal output waveform with less than 5% total harmonic distortion at full rated load. Dynamic brownout protection must maintain the desired voltage without continuously switching to batteries in low voltage situations up to -15%. The system shall maintain output regulation of less than $\pm 5\%$ under all operating condition except overload and short circuit. The system shall be able to protect itself from an internal over-temperature condition and issue an alarm under such conditions.
- B. To reduce operating cost while it is charging the battery system during normal utility power operation, the design must provide power factor correction close to unity (1.0 pf). The system shall include the following additional features;
 - a. An automatic, multi-rate, software controlled charger
 - b. Self diagnostic, programmable system testing capabilities
 - c. A microprocessor controlled diagnostic display panel capable of audible alarms
 - d. Visual displays of all alarms
 - e. A DC to AC converter (inverter)
 - f. A battery charger that meets the UL 924 standard
 - g. AC and DC input protection
 - h. A battery bank sized for the system's runtime requirements
 - i. Full KW rating at unity power factor

2.3 SYSTEM DESCRIPTION

- A. Inverter design requirements:
 1. Output Load Capacity – The continuous output power rating of the UPS shall be 8 kW.
 2. Input Voltage – 277 VAC, - 15% / + 10%
 3. Output Voltage – 277 VAC, 1 phase, 2 wires plus-ground
 4. Battery Autonomy – The UPS shall be capable of operating at full load for a minimum of 90-minutes on battery power at a temperature of 25° C.
 5. Efficiency – Greater than 90%
 6. Battery Type – Valve regulated sealed lead-acid (VRLA) standard; other types of batteries are optionally available.
 7. Battery Protection – Battery CB (Circuit Breaker), for safe UPS battery operation and servicing
 8. Cable Installation – Conduit entries on the top and both sides of enclosure
- B. AC input specifications:
 1. Input Voltages – 277 VAC, 2 wires plus ground
 2. Frequency – 60 Hz +/- 5%
 3. Input Current – Sinusoidal, close to unity capacitance under all line/load conditions (power factor correction)
 4. Input Protection – Contactor and optional input circuit breaker
 5. Input Surge Protection – SPD (Surge Protect Device)
 6. Transfer Time – Zero no break transfer (unit static transfer must not switch upon input power loss)

7. Slew Rate – 0.4 Hz/second, maximum
 8. Input Power Connections – Hard wired terminal block or optional input cable
 9. Number of Wires – Two (2) wires plus ground
 10. Cable Installation – Conduit entries on the top and both sides of enclosure
- C. AC output specification:
1. Output Ratings – 10kW.
 2. Output Voltages – 277 VAC
 3. Frequency – 60 Hz +/- 0.5 Hz
 4. Voltage Regulation – +/- 3% No load to full load, high line to low line (typical)
 5. Output Waveform – Sinusoidal
 6. Voltage Distortion – < 5% THD; < 3% Single Harmonic
 7. Inverter Overload Capability – 125% for 10 minutes, 150% surge for 10 seconds
 8. Bypass Overload Capability – 150%
 9. Protection – Fault current limited
 10. Non-Linear Load Capability – 100%
 11. Crest Factor – 3 to 1
 12. Output Power Connections – Hard wired terminal block or optional output receptacle panel board with NEMA type receptacles and over current protection (max 42 CBs)
 13. Output Distribution – The unit shall have an internal or external load center for customer use to eliminate the need for optional distribution
 14. Number of Wires – Two (2) wires plus ground

2.4 COMPONENT DESCRIPTIONS

- A. Input Terminal Block: For ease of installation, an input terminal block shall be hard wired and located in the UPS close to knockouts for incoming power cables. The conduit entries shall be located on the top and both sides of the cabinet.
- B. Input Circuit Breaker (optional): A circuit breaker shall be provided and hard wired at the UPS input for protection from the utility line and associated wiring disturbances. Optionally, a higher KAIC breaker shall be available and should be specified when required.
- C. Input Contactor: The UPS shall have a line contactor to isolate the rectifier in case of a line problem and allow for a smooth transfer or retransfer to and from bypass.
- D. Input Transformer: An input transformer shall be factory installed inside the standard UPS cabinet. It shall be located in the lower part of the cabinet with a barrier separating it from the electronics section to provide isolation between the line, rectifier and inverter circuits.
- E. Rectifier: A solid state circuit designed to convert incoming AC power to regulated DC bus voltage shall provide input to the inverter and battery charger.
- F. Inverter: The inverter shall feature PWM (Pulse-Width Modulation) design utilizing high frequency (15 kHz) switched IGBTs. It shall utilize a true double conversion system, generating rated AC output from the utility power or the batteries when in backup mode. The unit shall have a single heat sink and power IGBT assembly tray for reduced switching noise and maximum reliability. The assembly shall come as a FRU (Field Replaceable Unit) and its' design and mounting location shall provide for easy accessibility and maintenance. It shall be located on the electronics shelf to allow direct access when the door is opened and can be replaced in about 15 minutes using only a screwdriver.
- G. Charger: A separate battery charger circuit shall be provided. It shall use the same IGBTs as the inverter and have constant voltage and current limiting control. The battery float voltage will

be microprocessor programmable for the applicable kW and DC bus ratings. The charging current limit shall be temperature compensated for battery protection. Battery recharge design shall be in full compliance with UL 924. To increased ease and safety of service, a modularly designed Heat Sink Subassembly FRU shall combine the rectifier, inverter, charger, IGBTs and drivers into a single unit.

- H. Static Bypass: A continuous duty 100% rated bypass serves as an alternate source of power for the critical load when an input line failure or abnormal condition prevents operation in inverter mode. It will consist of a fully rated, continuous duty static switch for high-speed transfers and feature two back-to-back SCRs to allow make before break transfer. The design shall provide availability to include an optional manual bypass switch that is protected within the locked cabinet. It shall be accessible only to authorized personnel, allowing the unit to remain continually in bypass to allow a technician to safely work on the unit. Manual transfer to bypass shall not cause unit trip or transfer to the battery backup mode. To allow redundant input capabilities, the static switch shall be able to safely route power from an optional power source such as a generator or other power supply.
- a. Transfer to Bypass will initiate automatically under the following conditions:
 - Critical bus voltage out of limits
 - Total battery discharge (for specified backup time without damaging batteries)
 - Over temperature period expired
 - UPS problem
 - b. Automatic Re-transfer occurs whenever the inverter is capable of handling the critical load. It shall be inhibited for the following conditions:
 - When transfer to bypass is activated manually or remotely
 - When there is a UPS problem
 - c. All Transfers to bypass shall be inhibited under the following conditions:
 - Bypass voltage out of limits (+/- 10 % of nominal)
 - Bypass frequency out of limits (+/- 3 Hz)
- I. Control Logic: UPS operation shall be regulated by the microprocessor controlled logic. All operations, parameters, diagnostics, test and protection routines will be firmware controlled, compensating component drift and changes in operating environment to ensure stable and consistent performance. A self-test and diagnostic subroutine shall assist in troubleshooting the unit. The Control PCBA shall be located on the front door and be isolated from power wiring and switching devices. This arrangement shall minimize EMI and allow hot board swap in the manual bypass mode.
- J. Manual Maintenance Bypass Switch (Optional): An auto/manual MBS switch may be provided in the UPS cabinet for connecting power to the critical load through the external maintenance bypass line. It shall be used when the unit needs to be de-energized for maintenance, without disrupting power to the load. Operating the switch shall be strictly restricted to authorized personnel using a cabinet access key. The MBS shall have an auxiliary position that ensures full synchronization and prevents inrush current during transfer.

- K. Output Transformer: An output isolation transformer shall be utilized to provide specified output voltage and separate the UPS rectifier and inverter sections from load disturbances and conducted noise.
- L. Manual Inverter Test Switch: The unit shall have a momentary contact test switch to allow the user to accomplish a manual system test without the need to operate any breakers or shut down the system. The test switch shall be in compliance with UL924 specifications, well marked, accessible only after opening a locked front cabinet door and further protected from accidental activation. The Waverider 1 shall resume normal operation after the test switch is released.
- M. Battery Subsystem: Sealed, maintenance-free VRLA (**Valve-Regulated Lead-Acid**) batteries shall be provided. The batteries shall have an expected life of 10 years or a minimum of 250 complete discharge cycles. The batteries shall have a dedicated circuit breaker (no fuses) for battery protection and convenient power cut-off, and servicing. The battery run time (based on 100% full load) shall be no less than the specified time. Runtime shall comply with UL924 providing a minimum of 90-minutes at full load. Specified extended runtimes shall be provided only as an option.

2.5 SYSTEM DIAGNOSTICS AND ALARMS

- A. Front Panel LCD Display: A standard 4 line x 20 character back lit, blue front panel LCD display shall be used for instant indication of UPS status, metering, alarms and battery condition. The display will provide easy readout on two standard and two optional screens and provide continuous information with scrolling data.
- B. Status Display:
 - a. System Status
 - Standby – System is performing a self diagnostic
 - Start up – Inverter is starting
 - Normal – All parameter are acceptable
 - Problem – Loss of utility power or overload
 - Failure – System requires service
 - b. System Rating in KW
 - See tables on page 14 of 14
 - c. Battery Buss Voltage Status
 - Battery ok – Battery voltage is within an acceptable range
 - Battery bad – Battery voltage is out of range
 - d. Input Voltage Status
 - Input OK – Input voltage and frequency are within an acceptable range
 - Input bad – Input voltage and/or frequency is outside the acceptable range
 - e. Battery Charger Status
 - Charger on – Battery charger is charging or maintaining the battery at float voltage
 - Charger off – Battery is not being charged
 - f. System Internal DC Buss
 - DC OK – DC buss is within the acceptable range
 - DC bad – DC buss is out of the acceptable range

- g. Static Bypass Status
 - On inverter – Critical load is being powered and protected by the inverter
 - On by pass – Critical load is being powered from utility power
 - h. Inverter Output Status
 - Out ok – Output is within an acceptable range and the critical load is being power by the inverter
 - Out bad – No output is available from the inverter and the critical load is being powered by utility power
- C. Metering display:
 - Output voltage
 - Output power
 - Input voltage
 - Input current
 - DC buss
 - Battery voltage
 - Battery current (+) Charging (-) Discharging
- D. Events and Alarms screen - Optional
 - UPS Events Time/Date stamp up to 50 scrolling events with freeze function
- E. System Information Screen - Optional
 - Minutes on Battery – Shows UPS battery backup mode accrued time
 - System Hours – UPS in operation; total accrued time
 - Battery Event – The number of times the UPS operated in backup mode
 - Temp – The UPS cabinet temperature
- F. Alarm Relays (Optional): Standard dry contact signal relays close for each of the following alarm conditions: Input Fail, On Bypass, Inverter ON, Low Battery, Summary Alarm
- G. Communication Ports (Optional): The standard configuration will include two com ports configured for RS232 and one for RS485 data transfer. All parameters displayed on the front panel shall be available on these ports for remote monitoring.
- H. Power Flow Mimic (Optional): An optional laminated overlay with embedded color LEDs combine information on the front panel display with a graphic power flow visualization for instant load power status recognition.

2.6 MODES OF OPERATION

- A. The UPS module shall be designed to operate as an on line, high frequency (minimum 10 kHz), high precision PWM conversion, fully automatic system with “no break” transfer time in the following modes:
 - 1. **Normal:** During normal operation, utility (or generator) power is rectified to DC, drawing sinusoidal input AC current at unity power factor under all load conditions. The DC Rectifier supplies DC power to the Inverter and Battery Charger sections. Using high

frequency PWM (minimum 10 kHz) power technology, the inverter shall continuously support the load without using energy stored in the battery.

2. **Emergency:** Upon loss of input power or when power exceeds the specified input limits, the control logic shall allow the inverter to draw energy from the battery and disconnect the input line. The transfer to the battery shall be either uninterrupted; a "no break" power transfer, fast-transfer (within 2ms), or standard transfer (50-75ms), depending on option specified. The inverter shall supply power from the batteries to the critical load. The output voltage shall be sinusoidal and within the specified limits of 5% regulation. If power is not restored before the batteries have been exhausted, the UPS shall completely shutdown to protect the batteries from possible damage.
3. **Recharge:** When utility power is restored and before the batteries are completely exhausted, the UPS shall automatically return to normal operation. This retransfer to normal operation shall be uninterrupted. The battery charger shall automatically recharge the batteries to full capacity. Recharge characteristics must strictly comply with UL924 requirements.
4. **Bypass:** In the event of a component malfunction in either the Rectifier/Charger or the Inverter sections, the unit's static bypass switch shall transfer the load to the utility without interruption of power. Activation of the bypass mode shall cause an alarm indication and initiate output relay dry contact closure (for customer use).
5. **Off-Battery:** When the battery is removed for maintenance or the battery breaker is off, the unit will continue to function, meeting all the specified performance parameters with the exception of the power backup time capability.

2.7 BATTERY SPECIFICATIONS

1. Standard Run Time – 90 minutes at full load
2. Extended Run Time – As required
3. Battery Type – Sealed, maintenance-free, lead-acid, VRLA (Standard); other types are of batteries are optionally available
4. Expected Life – 10 years
5. Charger Ampacity – Per UL 924
6. Float Voltage – 2.25 V per cell
7. Protection – Main VDC Bus battery breaker
8. Nominal DC Link Voltage: kW, (dependent on the number of batteries). See chart on the last page.

2.8 SYSTEM DIAGNOSTICS/ALARM

- A. Front Panel LCD Display: Standard, 4 lines x 20 characters back lit, blue LCD display on the UPS for instant indication of UPS status, metering, alarms and battery condition. The display provides easy read-out on 2 standard and 2 optional screens, providing continuous information with scrolling uWRate:
- B. Status Display
 1. System Status
 - Standby: System is performing self-diagnostic
 - Start up: Inverter is being started
 - Normal: All parameter are acceptable

- Problem: Loss of utility power or overload
 - Failure: System requires service
- 2. System Rating in KW
- 3. Battery Buss Voltage Status
 - Battery ok: Battery voltage is within acceptable range
 - Battery bad: Battery voltage is out of range
- 4. Input Voltage Status
 - Input ok: Input voltage and frequency are within acceptable range
 - Input bad: Input voltage and/ or frequency is within acceptable range
- 5. Battery Charger Status
 - Charger on: Battery charger is charging or keeping batteries at float voltage
 - Charger off: Battery is being charged
- 6. System Internal DC Buss
 - DC ok: DC buss is within acceptable range
 - DC bad: DC buss is out of acceptable range
- 7. Static By Pass Status
 - On inverter: Critical load is being powered and protected by inverter
 - On by pass: Critical load is being powered from utility power
- 8. Inverter Output Status
 - Out ok: Output is within acceptable range critical load is being power by inverter
 - Out bad: No output is available from inverter and critical load is being powered from utility power
- C. Metering Display
 - 1. Output voltage
 - 2. Output power
 - 3. Input voltage
 - 4. Input current
 - 5. DC buss
 - 6. Battery voltage
 - 7. Battery current (+) Charging (-) Discharging
- D. Events and Alarms screen (Optional)
 - 1. UPS Events Time/Date stamp up to 50 scrolling events with freeze function
 - 2. Aux. Output CB Trip – up to 20 circuit breakers trip alarm on first priority trip screen
- E. System Information Screen – (Optional)
 - 1. Minutes on Battery: UPS in battery backup mode, accrued time
 - 2. System Hours: UPS in operation, accrued time
 - 3. Battery Event: number of times UPS operated in backup mode
 - 4. Temp: UPS cabinet temperature
- F. Alarm Relays (Optional): Dry contact signal relays close for each of the following alarm conditions: Input Fail, On Bypass, Inverter ON, Low Battery and Summary Alarm.
- G. Communication Ports (Optional): Two com ports can be made available; one configured for RS232 and one for RS485 data transfer. All parameters displayed on the front panel shall be available on these ports for remote monitoring.

- H. Power Flow Mimic (Optional): A laminated overlay with embedded color LED's combines information on the front panel display with a graphic power flow visualization for instant load power status recognition.

2.9 ACCESSORIES (OPTIONAL COMPONENTS)

- A. External Manual Bypass Switch: If specified by the customer, the bypass switch can be mounted in a separate enclosure and field mounted in the UPS cabinet or on an adjacent wall. This box includes a rotary switch with make before break contacts to provide a single control for transferring to and from maintenance bypass without load support interruption.
- B. Audio Alarm with Silence Switch: This option provides an audible warning signal acknowledge and reset for Input Fail, On Bypass, Inverter On, Low Battery and Summary Alarm for any of the previously mentioned alarm conditions.
- C. Remote UPS Status Panel: The Remote Status Panel is available in a console mount style box in a black finish. It can also be wall mounted and comes with a 10 foot long "DB" connector signal cable or optional cable that can be up to 1000 feet long. The Remote Status Panel requires 120 VAC power, comes with a 6-foot power cord and Silence and LED /Horn test switches. It includes the following LEDs: Input Fail, On Bypass, Inverter On, Low Battery and Summary Alarm.
- D. Form "C" Relay Contacts: Terminal strip TB is provided on the optional Alarm Relay Board for user connection to the individual alarm contacts. The Remote Contact Board includes isolated Form C contacts for Input Fail, On Bypass, Inverter On, Low Battery and Summary Alarm.
- E. External Status Indicator (for customer use): N/O volt-free contacts compatible with IBM AS400 standard shall be provided on a plug-in standard connector for the following signals: Low Battery, On Bypass, Summary Alarm and Input Fail.
- F. Normally On/Normally Off Output Auxiliary Circuit Breakers: These circuit breakers are single pole, 20 Amp devices for protection of the customer's load circuits.
- G. External Auxiliary Output Circuit Breaker Panel Board: This option provides up to 42 single-pole, 20 Amp output circuit breakers, which are located on an external panel board that can be mounted on the side of the UPS cabinet or adjacent wall.
- H. EMI Filter: The EMI filter complies with the following standards:
 - a. EN55022, 1998 Class "B" radiated emission
 - b. EN55022, 1998 Class "B" conducted emission
 - c. FCC Part 15 Class "B" radiated emission
 - d. FCC Part 15 Class "B" conducted emission
- I. Higher KAIC Norm On/Off Output Circuit Breaker: Single-pole, 20 A circuit breakers with higher KAIC can be mounted on a DIN rail or installed in a molded case.
- J. Seismic Mounting Brackets: Left and right seismic floor mounting brackets are available.
- K. Stackable Rack: This floor space saving accessory allows stacking of two racks in a single cabinet.

- L. **Battery Monitoring System:** This accessory provides string and entire system monitoring on a local, remote or web enabled PC. It provides for assessment of actual remaining charge and deterioration for maximum battery life and total backup safety.
- M. **Global Monitoring System (GMS):** All GMS items are optional. The GMS allows for flexibility in local and remote communications including internet access.
 - 1. **Local On UPS Display**
 - a. **Event Log:** Monitors the microprocessor circuit by acquiring system data. It displays up to fifty of the most recent date and time stamped events on the front panel display. It's key selectable menu provides access to events, system information, display, freeze and delete functions.
 - 2. **Local on PC - Via RS232:** This option requires a PC and LabView monitoring software on a Windows platform. Data sent to the PC are displayed as a control room panel for real-time monitoring. The distance from the PC for RS232 cable should be limited to between 25 and 150 feet.
 - 3. **Web/SNMP Card:** The optional Web/SNMP Card is a web enabled monitoring device for units with Internet or network connections. The internal IP internet address can be pre-installed in firmware to fit the customer's network settings. The Web/SNMP Card can monitor the UPS over a network using a standard web browser. Network management system software with an alarm viewer utility provides monitoring of multiple units on a single console

2.10 MAINTENANCE, SERVICE AND ENHANCED WARRANTY PLANS

- A. **Service Personnel:** The UPS manufacturer shall employ a nationwide service organization, with factory trained Customer Service Engineers dedicated to the startup, maintenance and repair of UPS and power equipment. The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel scheduling. One toll free number shall reach qualified support persons 24-hours a day, 7-days a week and 365-days a year. For emergency service calls, response time from a local Customer Engineer shall be approximately 15-minutes.
- B. **Replacement Parts:** Parts shall be available through an extensive network to ensure around-the-clock parts availability throughout the country. Customer Support Parts Coordinators shall be on call 24-hours a day, 7-days a week and 365-days a year for immediate parts dispatch. Parts shall be delivered to the site within 24-hours.
- C. **Maintenance Training:** In addition to the basic operator training conducted as a part of the system start-up, classroom courses for customer's employees shall be made available by the manufacturer. The course shall cover UPS safety, theory of operation, location of subassemblies, battery considerations and UPS operational procedures. It shall include AC/DC and DC/AC conversion techniques as well as control and metering, troubleshooting and fault isolation using alarm information and internal self-diagnostics with an emphasis on interpretation.
- D. **Maintenance Contracts:** A comprehensive offering of preventive and full service maintenance contracts shall be available. An extended warranty and preventive maintenance package shall be available. All services shall be performed by factory trained Service Engineers.
- E. **Site Testing:** The manufacturer's field service personnel shall provide site testing if requested. The testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer. A partial battery discharge test shall be provided as part of the

standard start-up procedure. The test results shall be documented, signed and dated for future reference

2.11 MECHANICAL DESIGN AND CONSTRUCTION

- A. **Enclosure:** All system components shall be housed in a single floor mounted freestanding NEMA 1 enclosure. The cabinet should have front access only with two doors, allowing easy component access from the front. The enclosure shall have shelves for component separation and clear and accessible layout. Cabinet doors shall require a key for gaining access. Front access only shall be required for safety and expedient servicing, adjustments and installation. The cabinets shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Enclosure design shall fully comply with UL 1778 for locked door, unauthorized access protection and UL 924 for accidental or unauthorized unit shutdown.
- B. **Construction:** Only quality, unused material shall be used to build the unit, under strict observance of standards and quality workmanship. The cabinets shall be cleaned, primed and painted matt black. The unit shall be constructed with rigorously tested, burned-in, replaceable subassemblies. Only two electronic subassemblies, a Heat Sink Assembly with IGBTs and drivers and a Control PCBA shall be used for maximum reliability and ease of servicing. All printed circuit assemblies shall have plug connections. Like assemblies and like components shall be interchangeable.
- C. **Earthquake Protection:** The cabinet shall be evaluated for earthquake Zone 4 installation with the addition of optional earthquake brackets.

2.12 OUTPUT DISTRIBUTION SECTION

- A. **Panelboard:** Comply with Division 26 Section "Panelboards" except provide assembly integral to equipment cabinet.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install system components on **[floor]** **[concrete base]** **[wall]** and attach by bolting.

1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details.
 2. Concrete Bases: **4 inches (100 mm)** high, reinforced, with chamfered edges. Extend base no more than **3 inches (75 mm)** in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 5. Use **3000-psi (20.7-MPa)**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "**Cast-in-Place Concrete**."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Wiring Installation: The UPS cabinet conduit entry arrangement shall allow for flexibility of user wiring installation. The wiring shall be routed thru the top or either side of the cabinet.
- D. Wiring Termination: The UPS input and output power connections shall be hard wired within the cabinet. Optional input line cable and output receptacle panels shall be available (limited range of units only – please consult factory for details). Input and output terminal blocks shall be provided for easy field wiring of the UPS and battery cabinets
- E. System Operation: The system shall allow connection of either "normally on" or "normally off" loads. Connected loads shall be carried via the transfer circuit by the utility during normal operation or by the system inverter during utility failures without interruption.
- F. Connected Loads: The Perfect Power Central Lighting Inverter system shall be designed to maintain the normal operation and performance integrity of all connected loads including voltage and frequency sensitive equipment by providing true "no break", continually conditioned sinusoidal output. Refer to plans for type and location of loads served by the system.
- G. Factory Startup: Provides a factory service representative to perform the initial startup of the Central Lighting Inverter System.
- H. Drawings and manuals: Drawings and manuals supplied with each unit shall include:
- a. Complete set(s) of shop drawings showing physical dimensions, mounting information and wiring diagrams
 - b. Installation Manual(s) with complete instructions for locating, mounting, interconnecting and wiring of the system
 - c. User Manual(s) outlining complete operating and preventive maintenance procedures
- I. Installation: The Central Lighting Inverter shall be installed in accordance with all appropriate manufacturers' installation instructions and in compliance with all appropriate codes.
- J. Environmental requirements
- a. Operating Temperature: 0°C to 40°C (32°F to 104°F)
 - b. Storage Temperature: - 20°C to +45°C (- 4°F to 113°F)
 - c. Maximum Recommended Storage Temperature for Batteries: 25°C (77°F) for up to six months. Storage at up to 40°C (104°F) is acceptable for a maximum of three months.
 - d. Humidity (operating and storage): 0 to 95% RH, non condensing

- e. Altitude: Up to 6000 ft (1,829 meters)
- f. Audible Noise: -57 dB typical on “response curve A”

K. Physical Specifications

- a. Cabinet shall be double door, floor mountable, fork lift compatible and painted black with a maximum depth of 18”, or 30.5”, to maximize front accessibility.
- b. Cabinet shall be 39” to no more than 51” width for best layout (book shelf style).
- c. Cabinet height shall not exceed 70” to allow pass through standard door.

| KW | Input/Output Voltages | MODEL NUMBERS | VDC | Cabinet Size UPS (Battery) (W x H x D) | Weights (lbs) | |
|------|---|------------------|-----|---|---------------|-------|
| | | | | | UPS | Batt. |
| 2.1 | 120/120 208/208 240/240 277/277 120, 208, 240, or 277 | WR3.0A0100N1-VA | 96 | 39” x 48” x 18” | | N/A |
| | | WR3.0B1300N1-VA | | | 826 | |
| | | WR3.0D0400N1-VA | | | 826 | |
| | | WR3.0R2500N1-VA | | | 826 | |
| | | *WR3.0X5800T1-VA | | | 896 | |
| 3.0 | 120/120 208/208 240/240 277/277 120, 208, 240, or 277 | WR3.0A0100N1 | 96 | 39” x 48” x 18” | 996 | N/A |
| | | WR3.0B1300N1 | | | 996 | |
| | | WR3.0D0400N1 | | | 996 | |
| | | WR3.0R2500N1 | | | 996 | |
| | | *WR3.0X5800T1 | | | 1066 | |
| 7.5 | 208/208 240/240 277/277 208, 240, or 277 | WR7.5B1300N1 | 120 | 51” x 70” x 31” | 2190 | N/A |
| | | WR7.5D0400N1 | | | 2190 | |
| | | WR7.5R2500N1 | | | 2190 | |
| | | *WR7.5X5800T1 | | | 2350 | |
| | | | | | | |
| 10 | 208/208 240/240 277/277 208, 240, or 277 | WR010B1300N1 | 192 | 51” x 70” x 31” | 2695 | N/A |
| | | WR010D0400N1 | | | 2695 | |
| | | WR010R2500N1 | | | 2695 | |
| | | *WR010X5800T1 | | | 2870 | |
| | | | | | | |
| 12.5 | 208/208 240/240 277/277 208, 240, or 277 | WR012B1300N1 | 192 | 51” x 70” x 31” | 3557 | N/A |
| | | WR012D0400N1 | | | 3557 | |
| | | WR012R2500N1 | | | 3557 | |
| | | *WR012X5800T1 | | | 3777 | |
| | | | | | | |
| 15 | 208/208 240/240 277/277 208, 240, or 277 | WR015B1300N1 | 240 | 51” x 70” x 31” | 4172 | N/A |
| | | WR015D0400N1 | | | 4172 | |
| | | WR015R2500N1 | | | 4172 | |
| | | *WR015X5800T1 | | | 4512 | |
| | | | | | | |
| 17 | 208/208 240/240 277/277 208, 240, or 277 | WR017B1300N1 | 240 | 51” x 70” x 31” | 4172 | N/A |
| | | WR017D0400N1 | | | 4172 | |
| | | WR017R2500N1 | | | 4172 | |
| | | *WR017X5800T1 | | | 4512 | |
| | | | | | | |

3.3 CONNECTIONS

- A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify equipment and components according to Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
 - 2. Test manual and automatic operational features and system protective and alarm functions.
 - 3. Test communication of status and alarms to remote monitoring equipment.
 - 4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Remove and replace malfunctioning units and retest as specified above.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that central battery inverter is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING AND CLEANING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. To be supplied at No charge if done at time of start up only. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 33 23

SECTION 26 41 00 - LIGHTNING PROTECTION SYSTEM

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 – GENERAL

1.1 SUMMARY

- A. To provide safety for the building and occupants by preventing damage to building structure caused by lightning.

1.2 REFERENCES

- A. The following specifications and standards of the latest issue form a part of this specification:
 - 1. Lightning Protection Institute Installation Standard, LPI 175
 - 2. Underwriters Laboratories, Inc. Installation Requirements, UL 96A
 - 3. National Electric Code (NEC)
 - 4. National Fire Protection Association Lightning Protection Code, NFPA 780

1.3 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 SYSTEM DESIGN

- A. The works covered by this section of the specifications consists of furnishing all labor, materials, and items of service required for the completion of a functional and unobtrusive lightning protection system as approved by the architect, engineer, and in strict accordance with this section of the specifications and the applicable contract drawings.
- B. If any departure from the contract drawings or submittal drawings covered below are deemed necessary by the contractor, details of such departures and reasons therefore shall be submitted as soon as practical to the architect, engineer for approval.

1.5 QUALITY ASSURANCE

- A. The lightning protection system shall conform to the requirements and standards for lightning protection systems of the LPI, UL, and NFPA. Upon completion, a certification letter and warranty by the installation company will be delivered to

the owner. The certification letter and warranty ensures the system has been installed by a company who employs LPI certified Master Designers and Installers and the building structure is protected by a lightning protection system meeting current standards. The lightning protection contractor is required to provide a LPI Master Certification, LPI Re-conditioned Certification or LPI Limited Scope Report from Lightning Protection Institute – Inspection Program (LPI-IP), depending on the lightning protection scope of work

- B. Installer Qualifications: Certified by **UL as a Master Installer/Designer**, trained and approved for installation of units required for this Project.
- C. System Certificate:
 - 1. UL Master Label.
 - 2. LPI System Certificate.
 - 3. UL Master Label Recertification.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

PART 2 – PRODUCTS

2.1 GENERAL

- A. The systems to be furnished under this specification shall be the standard product of manufacturers regularly engaged in the production of lightning protection equipment and shall be the latest approved design. The equipment shall be UL listed and properly UL labeled.
- B. All equipment shall be new, and of a design and construction to suit the application where it is used in accordance with accepted industry standards and LPI, UL, NFPA and NEC code requirements.
- C. Qualified Manufacturers:
 - 1. National Lightning Protection (NLP)
 - 2. Bonded Lightning Protection
 - 3. Thompson Lightning Protection
 - 4. Heary Brothers Lightning Protection Co., Inc.
 - 5. Erico, Inc. / A.C. Lightning

2.2 LIGHTNING PROTECTION EQUIPMENT

- A. All materials shall be copper and bronze of the size, weight and construction to suit the application and used in accordance with LPI, UL and NFPA code requirements. Class I sized components may be utilized on roof levels 75 feet and below in height. Class II sized components are required for roof levels over 75 feet in height. Bolt type connectors and splices shall be utilized on Class I and Class II structures. Pressure squeeze clamps are not acceptable. All mounting hardware shall be stainless to prevent corrosion.
- B. Comply with UL 96 **and NFPA 780**.
- C. Roof-Mounted Air Terminals: NFPA 780, **Class I, copper** unless otherwise indicated.

- D. All air terminals shall non-impalement or blunt tip type.
- E. Main and Bonding Conductors: **Copper**.
- F. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- G. Ground Rods: **[Copper-clad] [Zinc-coated] [Stainless] steel[, sectional type]; [3/4 inch (19 mm) in diameter by 10 feet (3 m)] [5/8 inch (16 mm) in diameter by 96 inches (2400 mm)] long.**
- H. Heavy-Duty, Stack-Mounted, Lightning Protection Components: **Stainless steel**.

2.3 ALUMINUM COMPONENTS

- A. Aluminum materials may not be used except on roofs that utilize aluminum roofing components. On aluminum metal roofs or where aluminum parapet caps exist, the entire roof lightning protection equipment shall utilize aluminum components to insure compatibility. However, the downloads and grounding are to utilize copper with the bimetal transition occurring at the roof through assembly with an approved bimetal through roof assembly.

2.4 SURGE PROTECTION DEVICES

- A. A surge protection device at the main electrical service entrance is required by lightning protection standards. The surge protection device must comply with UL Standard 1449 as a Type 1 or Type 2 lightning rated unit of 20kA or more. It shall be the responsibility of the Electrical Contractor to install or verify that a surge protection device is installed on the main electrical service.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The installation shall be by an experienced installation company that is UL listed a member of the Lightning Protection Institute and an employer of Certified Master Installers of lightning protection systems. For example: Taylor Lightning Protection, Katy, Texas 281-391-8778. A Certified Journeyman or Master Installer shall supervise the work.
- B. All equipment shall be installed in a neat, workmanlike manner. The system shall consist of a complete conductor network at the roof and include air terminals, connectors, splices, bonds, copper downloads, and proper ground terminals.
- C. Copper download cables shall be utilized even when aluminum is required on the roof. Download cables in conduit shall not be brought directly through the roof. Thru roof assemblies with solid brass or stainless steel rods shall be utilized for this purpose. Structural steel may be utilized in the installation as outlined by UL, NFPA and LPI.
- D. Install lightning protection components and systems according to **UL 96A and NFPA 780**.

- E. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- F. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view of exterior locations at grade within **200 feet (60 m)** of building.
- G. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- H. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 - 1.Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- I. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- K. Bond extremities of vertical metal bodies exceeding **60 feet (18 m)** in length to lightning protection components.
- L. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of **area or item indicated**.
 - 1.Bury ground ring not less than **24 inches (600 mm)** from building foundation.
 - 2.Bond ground terminals to the ground loop.
 - 3.Bond grounded building systems to the ground loop conductor within **12 feet (3.6 m)** of grade level.
- M. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at **60-foot (18-m)** intervals.

3.2 COORDINATION

- A. The lightning protection installer will work with other trades to insure a correct, neat and unobtrusive installation. The roofing contractor will be responsible for sealing and flashing all lightning protection roof penetrations as per the roof manufacturer's recommendations. However, the lightning protection contractor will be required to coordinate the locations of thru roofs and submit details of thru roof penetrations as required. Should the roofing manufacturer require any special walk pads, membrane patches or pavers under the components of the lightning protection system, it shall be the responsibility of the roofing contractor to install such items with the roofing materials (patches, pads, pavers, adhesive) supplied by the roofing manufacturer at no additional cost to the lightning protection installer.

- B. It shall be the responsibility of the lightning protection installer to assure a sound bond to the main water service and to assure interconnection with other ground systems.
- C. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- D. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- E. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

3.3 COMPLETION

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.
- D. Upon completion of the installation, the lightning protection installer shall conform to the requirements and standards for lightning protection systems of the LPI, UL, and NFPA. Upon completion the following certifications shall be delivered to the owner; a certification letter and warranty by the installation company, i.e: Bonded Lightning Protection Systems, Ltd., and a LPI Master Certification, LPI Re-conditioned Certification or LPI Limited Scope Report from Lightning Protection Institute – Inspection Program (LPI-IP), depending on the lightning protection scope of work.

END OF SECTION 26 41 00

SECTION 26 43 00 - SURGE PROTECTIVE DEVICES (SPDs) FOR LOW VOLTAGE POWER CIRCUITS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Section 26 43 00 – Surge Protective Devices, individually mounted and switchboard mounted. Switchboards: Surge Protective Device integrated in switchboards.

1.2 REFERENCES

- A. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
- B. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
- C. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
- D. National Electrical Code: Article 285
- E. UL 1283 - Electromagnetic Interference Filters
- F. UL 1449, Fourth Edition, effective September 29, 2009 – Surge Protective Devices

1.3 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: Submit capacity, dimensions, weights, details, and wiring configuration.
- C. Submittals shall include UL 1449 4th Edition Listing documentation verifiable by visiting www.UL.com, clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:
 - 1. Short Circuit Current Rating (SCCR)
 - 2. Voltage Protection Ratings (VPRs) for all modes
 - 3. Maximum Continuous Operating Voltage rating (MCOV)
 - 4. I-nominal rating (I-n)
 - 5. SPD shall be UL listed and labeled as Type 1 intended for Type 1 or Type 2 applications.
- D. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
- E. Minimum of ten (10) year warranty Manufacturer's Installation Instructions: Submit installation instructions and connection requirements.

1.4 QUALITY ASSURANCE

- A. List individual units under UL 1449 (Fourth Edition) and UL 1283 for type 2 locations.
- B. Single manufacturer: All equipment of each type shall be the product of one manufacturer.
- C. SPD shall comply with NEC Article 285 and shall be permanently marked with the short-circuit current rating of the device.
- D. Manufacturer Qualifications: Engage a firm with at least 5 years of experience in manufacturing of surge protective devices.
- E. Manufacturer shall be ISO 9001 or 9002 certified.
- F. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- G. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept equipment on site in factory packaging. Inspect for damage.
- B. Protect equipment from damage by providing temporary covers until construction is complete in adjacent space.
- C. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

PART 2 - PRODUCTS

2.1 SURGE PROTECTIVE DEVICES (SPDs)

- A. Manufacturers:
 - 1. Current Technology
 - 2. Emerson Network Power
 - 3. ASCO Power Technologies (APT)
 - 4. Siemens
 - 5. Square D
 - 6. GE
- B. Product Description: Surge protective devices for protection of AC electrical circuits.
- C. Unit Operating Voltage: As indicated on Drawings.
- D. Construction:
 - 1. Finish: Factory finish of baked enamel.
 - 2. Balanced Suppression Platform: Equally distribute surge current to Metal Oxide Varistor (MOV) components to ensure equal stressing and maximum

- performance. Furnish surge suppression platform with equal impedance paths to each matched MOV.
3. Internal Connections: Hardwired with connections using low impedance conductors and compression fittings.
 4. Safety and Diagnostic Monitoring: Equipped with standard overcurrent protection:
 - a. Continuous monitoring of fusing system.
 - b. Monitor individual MOV's (including neutral to ground). Capable of identifying open circuit failures not monitored by conventional fusing systems.
 - c. Monitor for overheating in each mode due to thermal runaway.
 - d. Furnish green and red solid state indicator light on each phase. Absence of green light and presence of red light indicates which phases have been damaged. Fault detection activates flashing trouble light. Units not capable of detecting open circuit damage, thermal conditions, and over current will not be accepted.
 5. Labeling: Permanently affix UL 1449 (Fourth Edition) suppression voltage ratings and CSA to unit.
- E. Types:
1. Distribution panelboards, Lighting and Appliance Panelboards; locate as stand-alone external. Component in housing adjacent to protected panelboard.
- F. Protection Modes: For Wye configured system, furnish device with directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For Delta configured system, furnish device with suppression elements between line to line (L-L) and line to ground (L-G).
- G. Distribution, Lighting and Appliance Panelboards:
1. Listing requirements: SPD shall bear the UL Mark and shall be Listed to most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL listing and does not meet the intent of this specification.
 2. Listing requirements: SPD and performance parameters shall be posted at www.UL.com under Category Code: VZCA. Products or parameters without posting at UL.com shall not be approved. (To access UL Category Code click on Certifications in the left menu bar of UL's home page. Type "VZCA" into the Category Code search box and click Search.)
 3. SPD shall be UL 1449 labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per NEC 285.6.
 4. SPD shall be UL 1449 labeled as Type 1 intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
 5. SPD shall be UL 1449 labeled with 20kA I-nominal (I-n) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.
 6. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems
 7. If a dedicated breaker for the SPD is not provided in the switchboard, the service entrance SPD shall include an integral UL Recognized disconnect switch. A dedicated breaker shall serve as a means of disconnect for distribution SPD's.
 8. SPD shall meet or exceed the following criteria:
 9. Minimum surge current capability (single pulse rated) per phase shall be:
 - a. Distribution applications:
Minimum surge current capability of 150kA per phase 65KA per mode.

10. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

| VOLTAGE | L-N | L-G | N-G |
|-----------|-------|-------|------|
| 208Y/120V | 600V | 700V | 600V |
| 480Y/277V | 1000V | 1000V | 900V |

UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com): Shall be at least 115% of nominal system voltage.

11. SPD shall include a serviceable, replaceable module (excluding Distribution). (Deletable note: Delete or adjust as appropriate.)
12. Service Entrance SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
13. SPD shall have a warranty for a period of ten (10) years. The manufacturer shall provide a full ten-year parts and five-year labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL Listing requirements and any applicable national, state or local electrical codes. Direct factory trained, ISO 9001:2000 certified employees must be available for 48-hour assessment. A 24-hour 800 number must be available to support warranty.
14. SPDs shall be equipped with the following diagnostics:
- a. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
 - b. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
 - c. Form C dry contacts one normally open (NO) and one normally closed (NC) for remote status monitoring.
 - d. Surge Counter

No other test equipment shall be required for SPD monitoring or testing before or after

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify mounting area is ready for equipment.
- B. Verify circuit rough-ins are at correct location.

3.2 INSTALLATION

- A. The installing contractor shall install the parallel SPD with short and straight conductors as practically possible. The contractor shall twist the SPD input conductors together to reduce input conductor inductance. The contractor shall follow the SPD manufacturer's recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes. When the SPD is installed external, lead lengths shall not exceed 5'.
- B. Install in accordance with IEEE 1100.
- C. Follow manufacturer suggested breaker size for SPD installations.
- D. Install suppressors for panelboards adjacent to panel.
- E. Include surge counter for stand-alone SPD.

- F. Install with maximum conductor length of 24 inches. Install suppressor with internal fusing.
- G. Provide 30 amp, 3 pole circuit breaker in panelboards to feed SPD.
- H. Provide 100 amp, 3 pole circuit breaker in switchboards to feed SPD.

END OF SECTION 26 43 00

SECTION 26 50 00 - INTERIOR LIGHTING

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes interior luminaires, lamps, ballasts, and accessories. Provide all luminaires complete with all new lamps, completely wired, controlled, and securely attached to supports.

1.2 REFERENCE STANDARDS

1. RoHS - Restriction of Hazardous Substances. Council of the European Union (EC) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
2. LM-79-08 (or latest) - IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
3. LM-80-08 (or latest) - IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
4. TM-21-11 (or latest) - IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
5. NEMA SSL 1-2010 (or latest) - Electronic Drivers for LED Devices, Arrays, or Systems.

1.3 DEFINITIONS

1. Driver - the power supply used to power LED luminaires, modules, or arrays.
2. L70, L₇₀, or L_{70%} - The reported life of an LED component or system to reach 70% lumen maintenance, or 70% of the LED's original light output. This test is being developed by the IES and is currently described by TM-21-11.
3. LED's - Broadly defined as complete luminaire with light emitting diode (LED) packages, modules, light bars or arrays, complete with driver.
4. LED luminaire failure - Negligible light output from more than 10 percent of the LED's constitutes luminaire failure.

1.4 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: Submit dimensions, ratings, and performance data.
- C. Photometric data for each luminaire, lamp and ballast. Include indications of all options and accessories as well as finish color.
- D. In addition to above for LED fixtures submit the following:
- Delivered lumens
 - Input watts
 - Efficacy
 - Color rendering index.

- E. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Provide luminaires listed by U.L.
 2. Luminaires installed in outdoor areas unprotected from weather to be U.L. Listed for wet locations.
 3. Insulated ceilings: Luminaires installed into insulated ceilings shall be U.L. Listed Type IC.
- B. Certification: Certify that fixtures submittal have trim compatible with ceilings being installed.

1.6 EXTRA MATERIALS

- A. Provide extra materials for Owners use. All parts shall be packaged in suitable carton.
- B. Provide ten (10) percent spare lamps of each lamp type. Deliver to Owner in original packaging.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- A. Product Description: Complete luminaire assemblies, with features, options, and accessories as scheduled.
- B. All luminaires shall be new and of specification grade.
- C. Manufacturer nomenclature in fixture schedule or otherwise described on the Drawings is given only to show the general fixture series. Contractor shall provide fixture with all required accessories and mounting frame type.
- D. Provide wire guard at fixtures in mechanical, electrical, and high abuse areas.

2.2 LED LUMINAIRES

- A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
- Minimum Light Output.
 - Zonal Lumen Requirements.
 - Minimum Luminaire Efficacy.
 - Minimum CRI.

- L70 Lumen Maintenance.
- Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.

Additional requirements:

- B. Color Temperature of 3000K-4100K for interior luminaires as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
- C. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 4-step MacAdam Ellipse binning process.
- D. Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
- E. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- F. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- G. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- H. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- I. Driver shall have a rated life of 50,000 hours, minimum.
- J. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- K. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- L. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- M. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- N. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- O. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- P. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Q. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- R. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- S. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- T. All luminaires shall be provided with knockouts for conduit connections.

- U. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).

2.3 LED LUMINAIRES USED FOR EMERGENCY EGRESS LIGHTING:

- A. The failure of one LED shall not affect the operation of the remaining LEDs.

2.4 EMERGENCY LED LUMINAIRE COMPATIBILITY WITH INVERTERS:

- A. Emergency Inverters shall be sine-wave type, or have written confirmation from the luminaire manufacturer that the luminaire will function with a square-wave inverter.

2.5 LED LUMINAIRE DRIVERS:

- A. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
- B. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
- C. Driver must limit inrush current.
 - 1. Base specification: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps² – seconds.
 - 2. Preferred Specification: Meet or exceed 30mA²s at 277VAC for up to 50 watts of load and 75A at 240us at 277VAC for 100 watts of load.
- D. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
- E. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
- F. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- G. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - 1. Adjustment of forward LED voltage, supporting 3V through 55V.
 - 2. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
 - 3. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

- H. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.
- I. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- J. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

2.6 LIGHT QUALITY

- A. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0% relative light output, or 100 – 1% light output and step to 0% where indicated. Driver shall respond similarly when raising from 0% to 100%
 - 1. Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
- B. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
- C. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

Specifier: To provide similar visual performance and illumination quality to existing fluorescent dimming solution, system should minimize flicker:

- D. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:
 - 1. LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
 - 2. Base specification: Flicker index shall less that 5% at all frequencies below 1000 Hz.
 - 3. Preferred specification: Flicker index shall be equal to incandescent, less that 1% at all frequencies below 1000 Hz.

2.7 CONTROL INPUT

- A. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - 1. Must meet IEC 60929 Annex E for General White Lighting LED drivers
 - 2. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
 - 3. Must meet ESTA E1.3 for RGBW LED drivers
- B. Digital (DALI Low Voltage Controlled) Dimming Drivers
 - 1. Must meet IEC 62386

- C. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
 - 1. Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address)
 - 2. Capable of signal interpolation and smoothing of color and intensity transitions

2.8 INSTALLATION

- A. To be installed per manufacturers prescribed methods.
- B. Driver may be remote mounted up to 300 ft. (100 m) depending on power level and wire gauge.

2.9 EMERGENCY BATTERY PACKS

- A. Provide Emergi-Lite FPSIU series, or approved equal, battery pack for fluorescent fixtures designated to have emergency battery back-up.
- B. Fixture shall include lighted push button test switch installed in visible, accessible location adjacent to fixture.
- C. Provide unswitched alternating current power source per manufacturer's instructions.
- D. Provide connection to local switch where indicated on drawings, connect such that fixture can be controlled on/off from local switch without discharge of battery.
- E. For fixtures designated to have emergency battery pack and be on a contactor controlled circuit, provide unswitched alternating current source ahead of contactor and wiring as required to allow automatic on/off control from the contactor without discharge of battery and local on/off switching where indicated.
- F. Battery pack shall provide min. 1400 lumen output for 90 minutes per 2'x4' light fixture.

2.10 DOWNLIGHT FIXTURES

- A. Provide recessed light fixtures with trim rings compatible with the ceiling material where fixture is to be installed.

2.11 COMPACT FLUORESCENT LAMPS (CFL)

- A. Provide Lamp with NEMA color RE 840. Lamp color temperature of 4100 Kelvin. Lamp color rendering index shall be 80 minimum.
- B. CFL shape shall be triple tube, installed vertical, unless luminaire schedule on Drawings states otherwise. Provide Phillips PL-T Series Amalgam CFL or approved equal.

2.12 ACCEPTABLE LAMP MANUFACTURERS

- A. Manufacturers:
 - 1. General Electric
 - 2. Osram Sylvania
 - 3. Venture Lighting
 - 4. North American Phillips
- B. Products shall be produced by manufacturers shown or as scheduled from each type of lighting fixture.

- C. Furnish all lamps of each type from the same manufacturer.

2.13 EXIT SIGNS

- A. Exit signs shall meet visibility requirements and be listed per UL 924 "Emergency Lighting and Power Equipment". Also shall meet Federal, State and Local Codes.
- B. Chevron Directional Indicator: Provide Chevron per NFPA 101 Section 5-10.4.1.2.
- C. Product Description:
 - 1. LED Exit Sign:
 - a. Provide exit sign with Light Emitting Diodes (LED) illuminance source. Cover LED with diffuser.
 - b. Output of fixture shall not exceed 5 amps.
- D. Housing: Diecast aluminum with stencil face and matte white paint finish.
- E. Input Voltage: 120/277 volt, dual input voltage.
- F. EPA Energy Star Label.
- G. Wire Guards: Install wire guard on all exit signs installed in gyms, lockers rooms, and athletic wing.

PART 3 - EXECUTION

3.1 EXISTING WORK

- 1. Disconnect and remove abandoned luminaires, lamps, poles and accessories.
- 2. Extend existing luminaire installation using materials and methods compatible with existing installation, or as specified.
- 3. Clean, repair and re-lamp all existing luminaires to remain or to be reinstalled.

3.2 INSTALLATION

- A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of lighting fixtures with other work.
- C. Adjust and Clean: Clean lighting fixtures of dirt and debris upon completion of the installation. Protect installed fixtures from damage during the remainder of the construction period.
- D. Field Quality Control: Upon completion of the installation of lighting fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- E. General: All luminaires shall have proper supports.

- F. Install suspended luminaires using pendants supported from swivel hangers.
- G. Locate recessed ceiling luminaires as indicated on Drawings.
- H. Install surface mounted ceiling luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- I. Chain Hung: Unless otherwise indicated all fluorescent fixtures in Mechanical, Electrical and Elevator Equipment Rooms shall be chain hung. See drawings for mounting heights. Verify exact mounting height with Architect before installing fixtures. Provide pendant hangers when equipment room has fire-resistive ceiling.
- J. Suspended Ceilings:
 - 1. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 12 gage hangers from each fixture housing at opposite corners to the building structure above (wires may be installed slack). Light fixtures shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system and supported from the building structure.
 - 2. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.
 - 3. Where the lighting design indicates multi-level lighting where 3 lamps fixtures are shown in a room, the outer 2 lamps will be switched from one switch and the center lamp will be switched from the other switch. Where 4 lamp fixtures are shown in a room, the outer 2 lamps will be switched from one switch and the center 2 lamps will be switched from the other switch. A similar multi-level lighting arrangement will be provided where 4-3 way switches are shown. Two ballasts must be used when dual level switching is shown.
 - 4. Ceiling tiles shall not bear the weight of luminaires. Surface mount luminaires, recessed downlights, light track, exit signs, etc. shall be supported by proper frames or other attachment to building structure above ceiling.
 - 5. Luminaires shall be centered in ceiling tile.
 - 6. Luminaire shall have flange or trim ring for closure of ceiling cutout or opening.
 - 7. Fire-rated Ceiling Assembly: For Luminaires to be flush-mounted into a fire-rated ceiling or surface mounted to a fire-rated ceiling, install with independent, secure support. Raceway, cable assemblies, boxes and fittings located above a fire-rated floor/ceiling or roof ceiling assembly shall not be secured to, or supported by, the ceiling assembly including the ceiling support wires. Provide an independent means of secure support. Independent support wires shall be

distinguishable by color, tagging, or other effective means from those that are part of the fire-rated design.

- K. Verify weights and recommended mounting methods of all luminaires with manufacturers. Furnish and install supports. All luminaires shall be supported independently of the outlet box.

3.3 LOCATIONS

- A. Luminaires shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings and to Architect on jobsite for more exact locations. Coordinate location with all other trades before installation. Coordinate all light fixtures in Mechanical Rooms with the final installed piping and ductwork layouts. Adjust fixture mounting height and location if required so that light output is not obstructed by piping and ductwork.

3.4 FIRE INTEGRITY OF CEILING PENETRATIONS

- A. Where ceiling is part of a fire-rated assembly, maintain integrity of that assembly with methods given in Section Electrical Hangers and Supports. Obtain ceiling system UL Fire Resistance Directory Design Number from Architectural Drawings.

3.5 AIMING AND ADJUSTMENT

- A. General: All adjustable lighting units shall be aimed, focused, and locked by the Contractor under the supervision of the Architect/Owner. All aiming and adjusting shall be carried out after the entire installation is complete.

3.6 LAMPS

- A. Clean all lamps after installation.

3.7 CLEANING

- A. Lens: Clean lenses of all luminaires after space is finished and prior to project acceptance.
- B. Louvers: Remove plastic bag from parabolic louver luminaires after space is finished and prior to project acceptance. Do not remove bags until luminaires have been cleared by the air-balance subcontractor.

3.8 RFI

- A. Provide flexible braided metal electrical bonding strap from grounded housing to door frame of all fluorescent parabolic fixtures in designated rooms. Bonding strap shall be braided conductor designed for field installation to either long door side.

END OF SECTION 26 50 00

SECTION 26 56 00 - EXTERIOR LIGHTING

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
 - 4. Luminaire lowering devices.
 - 5. Exterior luminaires with LED and driver.
- B. Related Sections:
 - 1. Section 265000 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.
- C. Basis of Design:
 - 1. All exterior building mounted lighting and pole mounted site lighting shall be LED unless otherwise noted on plans or in light fixture schedule.
 - 2. All exterior pole mounted site lighting fixtures shall be mounted on 25'-0" tall poles for access by standard bucket truck.
 - 3. All decorative pole mounted fixtures and decorative poles shall not exceed 15'-0" in height.
 - 4. Pole mounted site lighting to be installed within a parking lot, roadway or other area that is subject to vehicle traffic shall be installed on a min. 36" high concrete base as designed by Structural Engineer.
 - 5. Pole mounted site lighting to be installed in non-traffic area's to be installed on a min. 6" high concrete base as designed by Structural Engineer.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. HID: High-intensity discharge.

- D. LED: Light emitting diode
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. Pole: Luminaire support structure, including tower used for large area illumination.
- H. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M. Retain "Live Load" Paragraph below if Project includes pole-mounted walkways or service platforms.
- B. Diesel Standard: 2000 (IBC) International Building Code. Section 1609 requires wind forces on structure to be determined by the provisions of ASCE 7.
- C. Minimum Wind Speed: 120 miles per hour.
- D. Metal poles shall comply with NEC 410-15(b).

1.5 SUBMITTALS

- A. Specification Review: Provide a complete item by item, line by line specification review indicating compliance with the specifications and note any deviations from the specification with reason for deviation.
- B. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Photoelectric relays.
 - 7. Ballasts, including energy-efficiency data.
 - 8. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.
 - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

11. Anchor bolts for poles.
 12. Manufactured pole foundations.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 3. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 4. Wiring Diagrams: For power, signal, and control wiring.
- D. Samples: For products designated for sample submission in the Exterior Lighting Device Schedule. Each Sample shall include lamps and ballasts.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For **luminaires and poles** to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Glass and Plastic Lenses, Covers, and Other Optical Parts: **One for every 20** of each type and rating installed. Furnish at least one of each type.
 2. Globes and Guards: **One for every 20** of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least **12 inches (300 mm)** above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for LED Luminaires: **Ten** years from date of Substantial Completion.
 - 2. Warranty Period for LED Driver: **Five** years from date of Substantial Completion.
 - 3. Warranty Period for Metal Corrosion: **Five** years from date of Substantial Completion.
 - 4. Warranty Period for Color Retention: **Five** years from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than **three** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, **provide one of the products indicated on Drawings.**

2.2 LED LUMINAIRES

- A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
 - Minimum Light Output.
 - Zonal Lumen Requirements.
 - Minimum Luminaire Efficacy.
 - Minimum CRI.
 - L70 Lumen Maintenance.

- Minimum Luminaire Warranty of 5 years (not pro-rated) to include LED driver and all LED components.

Additional requirements:

- B. Color Temperature of 3000K-4100K as listed in the Luminaire Schedule on the plans. The color temperature of exterior LED luminaires should not exceed 4100K (nominal).
- C. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent luminaire-to-luminaire color for interior luminaires. Exterior luminaires shall use a maximum 4-step MacAdam Ellipse binning process.
- D. Glare Control: Exterior luminaires shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior luminaires.
- E. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
- F. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
- G. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
- H. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
- I. Driver shall have a rated life of 50,000 hours, minimum.
- J. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
- K. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
- L. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior luminaires, and a minimum of 70 for exterior luminaires.
- M. LED luminaire shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the luminaire is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
- N. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
- O. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
- P. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Q. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
- R. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- S. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
- T. All luminaires shall be provided with knockouts for conduit connections.
- U. The LED luminaire shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).

Provide all of the following data on submittals:

- Delivered lumens
- Input watts
- Efficacy
- Color rendering index.

2.3 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
 1. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
 2. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Architect's sample of **manufacturer's standard** color.
 - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 - 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: **Dark bronze** or custom color as selected by Architect from manufacturer's standard colors.
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USES ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, etc.), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start or programmed start) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.4 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at **1.5 to 3 fc (16 to 32 lx)** and off at **4.5 to 10 fc (48 to 108 lx)** with 15-second minimum time delay. **Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.]**
 - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of **1.1** to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of **2-1/2 by 5 inches (65 by 130 mm)**, with cover secured by stainless-steel captive screws. **Provide on all, except wood poles.**
- E. Pole accessories to include handhole and cover, full matching anchor bolt cover, anchor bolt kit, template, washers and leveling nuts.
- F. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- G. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- H. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.
- I. Pole Delivery: Unwrap pole upon delivery to job site, unless otherwise instructed by pole manufacturer. Wrapped poles exposed to weather that show wrapper striping or other

deterioration of finish shall be replaced at Contractor expense. Replacement shall be new pole or pole refinished at pole factory.

2.6 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of **46,000 psig (317 MPa)**; one-piece construction up to **40 feet (12 m)** in height with access handhole in pole wall.

(NOTE TO DESIGNER USE ROUND TAPERED STEEL POLES FOR WIND LOADS OVER 100 MILES PER HOUR)

1. Pole Shape: **Round, tapered.**
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: **Single-arm** type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with **stainless**-steel bolts.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Intermediate Handhole and Cable Support: Weathertight, **3-by-5-inch (76-by-127-mm)** handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- F. Grounding and Bonding Lugs: Welded **1/2-inch (13-mm)** threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- H. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.
- I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.
- K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if

- present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: **As indicated by manufacturer's designations.**

2.7 POLE ACCESSORIES

- A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Section 262726 "Wiring Devices" for ground-fault circuit-interrupter type where indicated on plans.
 1. **Recessed, 12 inches (300 mm)** above top of concrete base.
 2. Nonmetallic polycarbonate plastic or reinforced fiberglass, weatherproof in use, cover, **color to match pole**, that when mounted results in NEMA 250, **Type 3R** enclosure.
 3. With cord opening.
 4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
- B. Pole accessories to include handhole and cover, full matching anchor bolt cover, anchor bolt kit, template, washers and leveling nuts.
- C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- D. Decorative accessories, supplied by decorative pole manufacturer, include the following:
 1. Banner Arms: **same as pole.**
 2. Flag Holders: **same as pole.**
 3. Ladder Rests: **same as pole.**

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. **Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.**

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
1. Fire Hydrants and Storm Drainage Piping: **60 inches (1520 mm)**.
 2. Water, Gas, Electric, Communication, and Sewer Lines: **10 feet (3 m)**
 3. Trees: **15 feet (5 m)** from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 3. Install base covers unless otherwise indicated.
 4. Use a short piece of **1/2-inch- (13-mm-)** diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in **6-inch (150-mm)** layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
- F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
1. Make holes **6 inches (150 mm)** in diameter larger than pole diameter.
 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of **3000 psi (20 MPa)** at 28 days, and finish in a dome above finished grade.
 3. Use a short piece of **1/2-inch- (13-mm-)** diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
 4. Cure concrete a minimum of 72 hours before performing work on pole.
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of **6-inch- (150-mm-)** wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with **pea gravel** to a level **1 inch (25 mm)** below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).
- I. Pole Base: Do not grout space between pole base plate and top of concrete pole foundation. Leave open to allow water to drain and for pole to breathe. If grout is recommended by pole manufacture in space between pole base plate and top of concrete pole foundation, provide grout with drain hole through grouting.
- J. Poles shall be erected only with luminaire(s) or equivalent damping device, unless otherwise instructed by pole or luminaire manufacturer. Poles installed without luminaires are subject to increased modes of vibration.

- K. Do not level pole with shims; leveling nuts above and below pole baseplate provide flexible adjustment and long-term holding of pole position.
- L. Provide anchor bolts and pole manufacturer's bolt template prior to concrete formwork for pole bases.
- M. Minimum wire size for circuit tap inside pole shall be AWG #12.
- N. Install pole base cover. Cover shall rest on top of concrete pole foundation and completely conceal air space under pole base plate.

3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with ~~0.010-inch-~~ (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."

- b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00

SECTION 27 10 00 – STRUCTURED CABLING SYSTEM (SCS)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. Summary of Work:

Provide a complete and tested Structured Cabling System (SCS) for the interconnections of the Local Area Network (LAN). The SCS shall include fully terminated unshielded twisted pair cables, fiber optic cabling, raceways, conduit, back boxes, copper/fiber optic termination components, station mounting hardware, fiber optic enclosures, patch panels, copper/fiber optic patch cables, relay racks/cabinets, and other incidental and miscellaneous premises wiring system hardware as required for a complete, tested, and usable system that is in compliance with the latest NEC, ANSI/EIA/TIA, BICSI, and Authorities Having Jurisdiction codes and standards. The installation shall comply with all applicable requirements, design guidelines, and standards in effect at the job site and as indicated in the Drawings and Specifications.

1.3 QUALITY ASSURANCE

- A. Acceptable manufacturers:

- 1. The equipment/products described herein, and furnished per these specifications shall be the product of one manufacturer. All references to model numbers and other detailed descriptive data are intended to establish standards of design performance, and quality, as required.
- 2. Acceptable product shall be as follows:
 - a. For any new MDF/IDF locations that are established during this project, the end-to-end SCS solution shall be a complete category 6 solution.
 - b. Only products from the owner provided acceptable product list will be accepted.

- B. Installer Qualifications:

- 1. The Data Cable System Installer shall be licensed and shall meet all applicable regulations of the State of Texas and Department of Labor insofar as they apply to this type of system. The proposer shall be a firm normally employed in the low voltage and data cabling industry and shall provide a reference list of ten (10) large-scale projects and contact names confirming successful Category 6 premises wiring system installations.
- 2. The SCS Installer shall be a manufacturer certified, local area, integrator of the manufacturer's product and must be able to provide the manufacturer's maximum available warranty on the entire SCS. The contractor's certification must have been obtained and held within 100 miles of the project's location.
- 3. The installing contractor must have a full-time employed RCDD (Registered Communications Distribution Designer) on staff. Current RCDD certification shall be provided in the product submittals.
- 4. All individuals installing the SCS must be employees of the certified installer and at least 25% of the installing staff shall have undergone a training class given by the manufacturer. Current certification indicating the successful completion of the training course shall be available upon request at the project and submitted in the contractor's product submittals.

5. No portion of the SCS scope of work shall be subcontracted to any individual or company that does not meet the above requirements.
- C. Pre-Construction Meeting:
 1. The successful Contractor shall attend a mandatory pre-construction meeting with the project's consultant and individuals deemed necessary by the Owner's representative prior to the start of the work. No SCS work shall begin prior to this meeting.
- D. Acceptance:
 1. The Owner's representative reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.
- E. Warranty:
 1. The selected system installer shall be a certified installing contractor of product and hold current certification. Contractor shall be shall provide an end-to-end performance warranty of not less than twenty (25) years on all products installed. The proposer shall provide current certification documentation. The performance warranty shall be issued by the manufacturer and shall warrant that ALL Enhanced Category 6 cable links have been tested bi-directionally (end to end) using a Level 2 tester, per TSB-67, and that all test results conform to the most current TIA/EIA-568-A and/or TSB-67 Link values.
 2. The warranty will also cover all fiber optic cabling performance testing shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard, method B. The warranty will stipulate that all products used in this installation meet the prescribed mechanical and transmission specifications for such products as described in ISO/IEC 11801, ANSI/TIA/EIA-568-A, or EN 50173. Quality and workmanship evaluation shall be solely by the Owner/Designer and designated representatives.

1.4 REGULATORY REQUIREMENTS

A. Standards

All work shall be performed in accordance with the latest revisions of the following standards and codes:

1. Latest Local Codes and Amendments
2. 2008 National Electrical Code

B. Other References

1. TIA/EIA-568-A Commercial Building Telecommunications Wiring Standard
2. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
3. TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
4. TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
5. EIA/TIA 455-A Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices and Other Fiber Optic Components.
6. TIA/EIA TSB 67 Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems.
7. TIA/EIA TSB 72 Centralized Optical Fiber Cabling Guidelines
8. ISO/IEC 11801 Generic Cabling Standard
9. EN 50173 Generic Cabling Standards for Customer Premises

10. ANSI/EIA/TIA 526-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plan.

C. Governing Codes and Conflicts

If the requirements of these specifications or the Project Drawings exceed those of the governing codes and regulations, then the requirements of these specifications and the Drawings shall govern. However, nothing in the Drawings or Specifications shall be construed to permit work not conforming to all governing codes and regulations.

1.5 SUBMITTALS

A. Project Initiation

Within fourteen (14) days of Notice to Proceed, the data network system installer shall furnish the following in a single consolidated submittal:

1. Permits: The Contractor shall obtain all required permits and provide copies to the Owner/Architect/Engineer.
2. Product Literature: Complete manufacturer's product literature for all cable, patch panels, cross-connect blocks, cable supports, cable labels, outlet devices, and other products to be used in the installation. In addition, whenever substitutions for recommended products are made, samples (when requested by the Owner/Designer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included. The submittal shall have some type of distinguishing marker or pointer to indicate what specific product is to be provided.
3. Construction Schedule: A time-scaled Construction Schedule, using PERT/CPM, indicating general project deadlines and specific dates relating to the installation of the cable distribution system.
4. Testing: Proposed Contractor Category 6 UTP cable test result forms, fiber optic cable test result forms and a list of instrumentation to be used for systems testing.
5. **Line by line specification review stating compliance or deviation.**

B. Shop Drawings

Submit the following items, for Owner review and approval, within twenty-eight (28) days of notice to proceed:

1. Proposed circuit routing and circuit grouping plan prepared by a BICSI certified RCDD (Registered Communications Distribution Designer). The RCDD certification must be current.
2. Conformance: For items which are being provided exactly as specified, provide a letter stating the item description and model number, and that it is being provided as specified. For items which are not as specified, provide standard manufacturer's cut sheets or other descriptive information and a written description detailing the reason for the substitution.

C. Project Completion

As a condition for project acceptance, the Contractor shall submit the following for review and approval:

1. Samples: Complete manufacturer's product literature and samples for all pre-approved substitutions to the recommended products made during the course of the Project.

2. Inspection and Test Reports: During the course of the project, the Contractor shall maintain an adequate inspection system to insure that the materials supplied and the work performed conform to Contract requirements. The contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation, which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion.
3. Operating and Maintenance Instructions: Operating and maintenance instructions for all devices within the system. These instructions shall reflect any changes made during the course of construction, and shall be provided to the Owner for their use in a three-ring binder labeled with the project name and description (4 copies).
4. As-Built Drawings: As-built drawings will include cable pathways, data outlet locations with correct labeling and MDF location. The as-built drawings will be prepared using AutoCAD version 2006 or later. Provide the Owner with one Mylar plot of each drawing and two blue line prints of each drawing. Provide the Owner with electronic versions of the as-built drawings on (2) CD Rom disk.
5. One (1) 30" x 42" laminated floor plan sheets illustrating technology drops and cable designation for each Floor. Two (2) 30" x 42" laminated floor plan sheets illustrating technology drops and cable designation for each telecommunications room (MDF or IDF) mounted on wall. Coordinate mounting locations with owner prior to installation.

PART 2 – PRODUCTS

2.1 GENERAL

A. Installation:

The cabling shall be installed per requirements of the manufacturer and the Project Documents utilizing materials meeting all applicable TIA/EIA standards. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Materials

Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the TIA/EIA specifications. All approved equivalent products will be published by addendum ten days prior to proposal for Architect/Engineer to review.

C. UTP Testing

1. Notification: The Owner and Engineer shall be notified one week prior to any testing so that the testing may be witnessed.
2. Inspection: Before requesting a final inspection, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the test procedures, test result forms and timetable for all copper and fiber optic cabling.
3. Procedures: Trained personnel shall perform all testing. Acceptance of the test procedures discussed below is predicated on the Contractor's use of the recommended products and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.
4. Errors: When errors are found, the source of each shall be determined, corrected and the cable retested. All defective components shall be replaced and retested. Re-test results must be provided on Owner approved forms and witnessed by Owner.

5. Twisted Pair Cable Testing:
 - a. At a minimum, the Contractor shall test all station drop cable pairs from Data Closet termination patch panels to outlet device RJ45 jacks. Category 6 products shall be tested for compliance to ANSI/TIA/EIA 568A and ISO/IES 11801 for a Category 6 rated installation. Test equipment used shall meet TIA/EIA TSB-67, Level II accuracy. Further, the contractor shall have a copy of TSB-67 in their possession and be familiar with its contents.
 - b. Each wire/pair shall be tested at both ends for the following:
 - 1) Wire map (pin to pin connectivity)
 - 2) Length (in feet)
 - 3) Attenuation
 - 4) Near end cross talk (NEXT)
 - 5) Power Sum
 - c. Test equipment shall provide an electronic and printed record of these tests. Test results will be required for warranty. Any un-witnessed testing is at risk of not receiving a manufactures warranty.
 - d. Approved Product Multi-pair Copper – CommScope 25-pair Cat 5e PN – 760026518
Approved Product Horizontal Copper – CommScope Cat 6 GigaSPEED Plenum PN – 700208093
 - e.

| Color | Trade |
|--------------|---------------|
| Blue | Data/Wireless |
| Yellow | Cameras |
| White | Intercom |
| Green | Lighting/HVAC |
| Red | Fire |
| Security | Grey |
6. Fiber Optic Testing
 - a. Testing device for fiber optic cables shall be a high quality OTDR (Optical Time-Domain Reflectometer) equipped with a printer. The printed data shall show, in addition to any summary information, the complete test trace and all relevant scale settings. The OTDR must have the capability to take measurements from bare fiber strands as well as SC connector terminations.
 - b. All fiber optic cable shall be tested on the reel before installation to insure that it meets the specifications outlined herein.
 - c. After installation the Contractor shall test each fiber strand in accordance the EIA 455-171 Method D procedures (bi-directional testing) at both 850nm and 1300nm for multimode or 1310nm and 1550nm for single mode. A form shall be completed for each cable showing data recorded for each strand including length, total segment (end-to-end) loss (dB) and connector losses (dB) at each end. In addition, the printed data strip for each strand shall be attached to the form. Patch cables shall also be tested.
 - d. Acceptable fiber optic connector loss shall not exceed .75dB per mated pair. The Contractor is responsible for obtaining minimum loss in fiber connections and polishing per manufacturer specifications.
 - e. Single mode:
 1. Single mode fibers shall have a maximum attenuation of 1.0 dB/km at 1310 nm and 1.0 dB/km at 1550 nm.
 - f. Multimode:
 1. 50um micron multimode fibers shall have a maximum attenuation of 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm. Minimum bandwidth shall be 2000 MHz/km at 850 nm and 500 MHz/km at 1300 nm.
 2. Approved Product: CommScope PN - 760171470
 - g. OTDR shots shall be provided for each strand of fiber optics completely installed and terminated.

D. Ratings

All products shall be new and brought to the job site in the original manufacturer's packaging. Electrical components (including inner duct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows:

| | |
|-----|-----------------------------------|
| CM | Communications Cable |
| CMP | Plenum Rated Communications Cable |
| CMR | Riser-Rated Communications Cable |

E. Initial Cable Inspection

The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of the proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket that would indicate possible problems. Damaged cable or any other components failing to meet specifications shall not be used in the installation.

F. Cable Lubricants

Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit.

G. Fire Wall Sealant

Any penetration through firewalls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved sealant.

2.2 DATA CLOSET (MDF/IDF) CATEGORY 6 TERMINATION HARDWARE

A. Equipment Racks

Provide and install equipment racks in locations indicated on the attached drawings for the following areas.

For all MDF/ IDF locations:

Contractor shall provide and install new two post rack. Refer to floor plan and enlarged IDF room layouts for number or racks to provide at each location.

Approved Products:

CommScope 2- Post Rack – PN - RK3-45A

B. Distribution Rack Grounding

All Racks and/or Cabinets shall be individually grounded using stranded #6 AWG insulated copper conductor, from the rack to the telecommunication ground bus bar, with copper compression lugs at both ends of the grounding wire. DAISY CHAINING RACKS TOGETHER WILL NOT BE ACCEPTED. Provide all required bonding materials and hardware and bond to building grounding electrode subsystem at building electrical service entrance.

C. Fiber Optic Patch Panels

The enclosures used shall provide termination panels for LC type connectors and be of sufficient size and capacity to terminate 110% of the fiber count of the inside of outside fiber optic cables. Patch panels must be 19" rack mountable. Provide all termination accessories, fiber patch cords, enclosures and test for a complete fiber optic distribution system.

Approved Products:
CommScope FIBER LIU – PN - 360G2-1U-MOD-SD

D. Category 6 Patch Panels

The Category 6 data station cable shall be terminated on Category 6 patch panels, T568B terminations. Patch panels shall be 19-inch rack mountable. Workstation patch panels shall terminate all workstation communications outlets. Furnish units that adhere to the performance requirements TIA/EIA-568A standards.

Approved Products:
CommScope 48 Port Patch Panel – PN - 360-PM-GS3-2U-48

E. Rack Electrical:

1. Provide (1) power strips on the back of each 7' data relay rack.

F. Cable Management Panels

Provide cable management panels as required for horizontal and vertical cable management. Provide vertical wire management on ends and in between all racks on entire project.

Approved Products:
CommScope Vertical Cable Mgmt. Kit – PN - VCM-DS-84-6

G. Network Rack Patch Cables

Cabling Contractor shall provide the owner with (1) – 10' Category 6 patch cable for each data drop on entire project. These cables will provide connectivity at the user end. Contractor will also provide (1) 6" and 1' patch cables as listed below for each drop on the patch panel side. Colors to be allocated per discipline.

1. Approved products shall be factory terminated category 6 patch cables and must be of the same manufacturer as the installed end-to end Structured cabling System.

| | |
|--------------------------|---|
| Approved Products: | |
| CommScope CPC3312-0ZF010 | 10ft Cat6 Blue Patch Cords – Blue 48 Each |
| CO166S2-0ZN006 | 6 inch blue panel patch cord – Blue (Data) |
| CO166S2-09N006 | 6 inch yellow panel patch cord – Yellow (Cameras) |
| CO166S2-08N006 | 6 inch white panel patch cord – White (Intercom) |
| CO166S2-0ZF001 | 1FT blue panel patch cord – Blue (Data) |
| CO166S2-09F001 | 1FT yellow panel patch cord – Yellow (Cameras) |
| CO166S2-08F001 | 1FT white panel patch cord – White (Intercom) |
| FFXLCLC42-MXF006 | LC/LC Fiber Patch Cords – Aqua |

2.3 CABLE ROUTING/PATHWAY

A. Cable Support System:

For all areas that will not receive Basket tray, all low voltage cabling shall be installed and supported using Com dangle CD12W Clips on wire. Contractor shall provide separate wire from ceiling support wire. No cable shall be installed using ceiling supports or support wires used by any other trade Install supports at 5'-0" intervals unless installed in conduit. Do not exceed

manufacture recommendation for the quantity of cables supported in an individual support.

- B. All cable bundles shall be grouped together using plenum rated Velcro for the entire run above and below the ceilings. Zip Ties will not be accepted.
- C. The part numbers listed above are for MDF and IDF's only. Refer to Cable Basket Tray Specifications for Corridor and Work area Basket Tray materials and methods.
- D. The contractor shall provide conduit raceway for all areas with exposed ceiling.

2.4 STATION WIRING

- A. Wire

The data and voice wire provided for all outlets shall be (Category 6) unshielded twisted pair, four-pair, 23 AWG solid copper conductor, meeting the intent and quality level of the TIA/EIA-568-A Commercial Building Wiring Standard. Refer to floor plan and data outlet legend for number of active data ports to specified faceplates.

- B. Testing

- C. The four-pair UTP cable must be UL Performance Level tested. Each 1000 or 3000 foot spool shall be new and must be individually tested with test results available at upon request. "SHORTS" WILL NOT BE ALLOWED AND IF DISCOVERED, CONTRACTOR WILL BE REQUIRED TO REMOVE ALL CABLE AND REINSTALL AT NO ADDITIONAL COST TO OWNER.

- D. Rating

Cable installed in conduit shall be non-plenum rated. Cable not installed in conduit shall be plenum rated if installed in plenum ceiling space, non-plenum rated otherwise.

2.5 STATION HARDWARE

- A. Flush Mount Jacks

Flush mount jacks shall be high quality Category 6 RJ45 modular jacks with circuit board construction and IDC style or 110-style wire, T568B terminations. Jacks shall meet EIA/TIA TSB40 recommendations for Category 6 connecting hardware.

- B. Faceplates

- 1. Faceplates shall match electrical faceplates in color at all locations. Face plates will use Nylon and Stainless steel faceplates at various locations.

- C. Workstation Patch Cables

Cabling Contractor shall provide the owner with one (1) 10' patch cable for each data on entire project. Each cable will be terminated properly with RJ45 connections on each end with appropriate pin-out assignments per project configuration. In work space areas Patch cable shall be of sufficient length to be routed from the outlet to the workstation, provide Lengths as required: For offices, conference rooms and classroom provide 10' cables

Approved products shall be factory terminated category 6 patch cables and must be of the same manufacturer as the installed end- to end Structured cabling System.

A. Fiber Optic Cable shall be UL listed type OFNP (unless noted otherwise):

1. Multimode:

50/125um micron multimode fibers, each with a color-coded PVC tight buffer shall have a maximum attenuation of 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm. Minimum bandwidth shall be 2000 MHz/km at 850 nm and 500 MHz/km at 1300 nm and contain no metallic elements.

3. No fusion or mechanical splices will be allowed at any point in the fiber optic runs, unless specifically noted otherwise.

B. Connectors

Optical Fiber Connectors shall be LC type connectors.

PART 3 – EXECUTION

3.1 GENERAL

A. Fire Wall Penetrations

The contractor shall avoid penetration of fire-rated walls and floors wherever possible. Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.

B. Allowable Cable Bend Radius And Pull Tension

In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation. Refer to the cable manufacturers allowable bend radius and pull tension data for the maximum allowable limits.

C. Cable Lubricants

After installation, exposed cable and other surfaces must be cleaned free of lubricant residue.

D. Pull Strings

Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract. Pull test is not to exceed 200 pounds. Data and video cables can be pulled together with pull strings.

E. Conduit Fill

Conduit fill shall not exceed 40%.

F. Damage

1. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over-tightened bindings, loosely twisted and over-twisted pairs at terminals and cable sheath removed too far (over 1-1/2 inches).
2. The Contractor shall replace any damaged ceiling tiles that are broken during cable installation.

G. Clean Up

All clean up activity related to work performed will be the responsibility of the Contractor and

must be completed daily before leaving the facility.

3.2 DOCUMENTATION

A. Labels

The Contractor will label all outlets using permanent/legible typed or machine engraved labels approved by the Owner (no handwritten labels permitted). Label patch panels in the wiring closet to match those on the corresponding data outlets. The font shall be at least one-eighth inch (1/8") in height, block. All labels shall correspond to as-builts and to final test reports.

The following nomenclature should be used when labeling data/voice jacks:

All cables being served by MDF closet shall begin with 'MDF' all IDF served cables shall begin with 'IDF' # (# designated IDF closet number).

Next identification letter shall refer to patch panel that is serving outlet (A,B,C...)

Next identification shall note what # data port on patch panel (1 thru 48).

Example:

Outlet from 23rd port of the third patch panel from top of rack located at IDF-2

IDF 2 - C23

Outlet from the 5th port of the second patch panel from the top of rack located at MDF

MDF - B5

B. Floor Plan

A floor plan clearly labeled with all outlet jack numbers shall be included in the as-built plans.

C. Cables: All cables shall be labeled at both ends. This includes but not limited to horizontal voice and data cabling, copper backbone tie cables, and fiber optic cables.

D. Fiber Optics: Fiber optic strands shall be labeled at both ends on the fiber distribution panel.

E. Equipment racks: Equipment racks shall bear at least one indicating label indicated MDF or IDF. If rack is installed in IDF, label shall include IDF #.

F. Access Points: Label ceiling grid with digital label according to location installed.

3.3 EQUIPMENT RACK CONFIGURATION

A. Equipment Racks

1. Equipment racks shall be assembled and mounted in locations shown on the Drawings and as detailed. Each rack shall be securely mounted to the floor and braced to the wall with cable tray in accordance with the manufacturer's instructions and recommendations. Racks shall be mounted such that the side rails are plumb with vertical cable management panels. Racks to be located such that future expansion can occur without relocating existing racks. Racks shall be grounded in accordance with NEC requirements.

- B. Cable Placement
Cable installation in the Wiring Closet must conform to the Project Drawings. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance location. Avoid crossing area horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty at a later time by maintaining a working distance from these openings.
- C. Cable Routing
Cable shall be routed as close as possible to the ceiling, floor or corners to ensure that adequate wall or backboard space is available for current and future equipment. All cable runs within the Wiring Closet shall be horizontal or vertical within the constraints of minimum cable bending radii. Minimum bend radius shall be observed. Cables shall not be tie-wrapped to electrical conduit or other equipment.
- D. Installation
All incoming cables shall be routed on the cable tray and neatly dressed down to the patch panels.
- E. Hardware
Provide rack and jack panel hardware as required for all data station wiring.

3.4 STATION WIRING INSTALLATION

- A. General
Cabling between wiring closet and workstation locations shall be made as individual home runs. No intermediate punch down blocks or splices may be installed or utilized between the wiring closet and the communications outlet at the workstation location.
All cable must be handled with care during installation so as not to change performance specifications. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable. There shall never be more than one and one-half inches of unsheathed enhanced Category 6 UTP cable at either the wiring closet or the workstation termination locations.
- B. Exposed Cable
All cabling shall be installed inside walls or ceiling spaces whenever possible. Exposed cables and/or cables routing through mechanical rooms, electrical rooms, or restrooms shall be installed inside conduits, unless noted otherwise on the project drawings.
Additional exposed cable runs will require Owner approval, and will only be allowed when no other options exist.
All cable routing through conduits and sleeves shall maintain a 40% maximum conduit fill ratio.
- C. Placement
All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Owner's efficient use of their full capacity.
- D. Cable Routes
All cabling placed in ceiling areas must be in conduit, cable tray or J-Hooks. Cable supports shall be permanently anchored to building structure or substrates. Provide attachment hardware and anchors designed for the structure to which attached and that are suitably sized to carry the weight of the cables to be supported. Do not route cable through webbing of structural steel. Cabling must be supported in dedicated supports intended to support cabling as described in this section. Contractor shall adhere to the manufacturer's suggested fill ratio for each size cable support installed.
Attaching cable to pipes or other mechanical items is not permitted. Communications cable shall be rerouted so as to provide a minimum of 18 inches spacing from light fixtures, sources

of heat, power feeder conduits and EMI sources. Cabling shall not be attached to ceiling. Grid support wires. Cable runs shall be routed down the corridors; parallel or perpendicular to building structure. Multiple cables to be bundled together at and between each cable support installed.

Contractor shall be responsible for coordinating with other trades on the project so that the installed cable pathway does not interfere with the installation of other systems to insure that mechanical ducts, pipes, conduits, or any other above ceiling systems are not putting unnecessary stress on any portion of the install SCS.

3.5 STATION HARDWARE

- A. Flush Mount Jacks
Flush mount jacks shall be mounted in a faceplate with back box.
- B. Placement
 - 1. Where possible, the communications outlet shall be located so that its centerline is 18 inches above floor level or 12 inches above permanent bench surfaces. Outlets shall not be mounted on temporary, movable, or removable surfaces, doors, or access hatches.
 - 2. Outlets shall be installed within 3'-0" of power outlets
- C. RJ-45 Jack Pin Assignments
 - 1. Pin connections for data station cable outlets and patch panels shall match EIA/TIA 568 modular jack wiring recommendation T568B.
 - 2. Pin connections at data jack panels shall match pin connections at outlets (straight through wiring)
- D. Faceplate Icons: Contractor shall install faceplate icons.

3.6 CABLE TESTING REQUIREMENTS

- A. Notification
The Owner and Engineer shall be notified one week prior to any testing so that the testing may be witnessed.
- B. Inspection
Conformance to the installation practices covered above is to be verified when completed. In some cases, the Owner/Designer may inspect before acceptance.
 - 1. Written Test Report:
 - a. Complete test results, including actual values associated with tests.
 - b. Show all certifications for telecommunications wiring systems.
 - c. Include cable maps showing each cable route and keyed to cable labels. Provide owner with complete floor plans identifying outlet location and cable routing drawing in AutoCAD format. Provide electronic copy of drawings to owner in AutoCAD version 2004 or greater.
 - d. Documentation of outlet, cable and rack labeling system.

After performing all tests, tabulate results and bind together in format acceptable to Owner. Installer shall provide written certification in the test report that telecommunications cable is properly installed and test results certify system to all specified standards.

- C. Procedures
Trained personnel shall perform all testing. Acceptance of the test procedures discussed below is predicated on the Contractor's use of the recommended products and adherence to the

inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.

D. Errors

When errors are found, the source of each shall be determined, corrected and the cable retested. All defective components shall be replaced and retested. Re-test results must be provided on Owner approved forms and witnessed by Owner.

E. Twisted Pair Cable Testing

1. At a minimum, the Contractor shall test all station drop cable pairs from Data Closet termination patch panels to outlet device RJ45 jacks. Category 6 products shall be tested for compliance to ANSI/TIA/EIA 568A and ISO/IES 11801 for a Category 6 rated installation. Test equipment used shall meet TIA/EIA TSB-67, Level II accuracy. Further, the contractor shall have a copy of TSB-67 in their possession and be familiar with its contents.
2. Each wire/pair shall be tested at both ends for the following:
 - a. Wire map (pin to pin connectivity)
 - b. Length (in feet)
 - c. Attenuation
 - d. Near end cross talk (NEXT)
 - e. Power Sum
 - f. ACR
3. Test equipment shall provide an electronic and printed record of these tests.
4. Test results for each Enhanced Category 6 four-pair UTP cable must be submitted with identification to match labels on all patch panel ports and user outlets and must match as-built drawings associated with that cable.

F. Testing

Once installed the cabling will be tested for continuity, shorts and grounds.

1. Cabling

- a. Continuity – 100% continuity testing is required and will be tested from the MDF/IDF location to each classroom drop. A checklist of each cable and test performed on that cable will be submitted once the testing has been completed.
- b. Shorts – No cable shorts will be permitted on the system. If a short is detected, the connector or cable will be repaired or replaced.
- c. Grounds – No direct ground on the center conductor of the AVDN cables are permitted.

2. System

- a. Continuity – As tested in the above testing requirements.
- b. Power Readings – A power reading will be required at each drop of each of the cabling systems. A +3 dB to a +7 dB is required at each drop with a common feed signal of + 15 dB into the head end amplifier. These measurements to be taken with an approved field strength meter of known calibration. Test measurements to be performed at low channel, mid-band channel, and high channel to determine cable slope.
- c. Signal Quality – A standard receiver, typical of those used in the system, shall randomly be connected to 10% of the outlets across the system and tuned to a reference channel of known quality. No visible indication of co-channel interference, noise, ghosting, or beat interference may be observed.
- d. Carrier to Noise – Carrier to Noise shall be measured at random outlets representing an average cross section of the drops with an approved field strength meter by the following process. With normal operating levels the field set shall be tuned to each channels visual carrier and the level recorded. The input signal to

the head end amplifier shall be removed and the input of the amplifier terminated with a short. Each channel shall be re-measured and the noise levels recorded. The Carrier to Noise measurement is the difference of the two figures.

- e. Documentation of Results – All recorded measurements are to be tabulated and included in the systems documentation manual for reference during maintenance of the system.

3.7 INSPECTION

- A. General
Conformance to the installation practices covered above is to be verified when completed. In some cases, the Owner/Designer may inspect before acceptance.

END OF SECTION 27 10 00

SECTION 27 51 00 INTEGRATED TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL

- A. The conditions of the General Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.
- B. All Bids shall be based on the equipment as specified herein to tie into the existing Rauland Telecenter 21 Life Safety Communication solution.

1.2 SCOPE OF WORK

- A. Furnish and install all equipment, accessories, and materials required to tie all new equipment required to the existing intercom headend system. The contractor shall provide and install an new program source and equipment
 - 1. Two way communication between any call button and any classroom speaker.
 - 2. Public automated building exchangesystem.
- B. Telephone service with public utilities shall be arranged by the owner, in conjunction with the equipment supplier. Equipment supplier shall generate a one page document that will provide the Owner with information concerning number of outside lines (minimum of 8), number of digital sets request for bell schedule and architectural room numbers.

1.3 SUBMITTALS

- A. The vendor shall provide the following documentation and service:
 - 1. Shop drawings: 1 set. These drawings shall include the manufacturers' specification sheets, including all component parts.
 - 2. As-built drawings: 1 set. They should include up-to-date drawings including any changes made to the system during installation. Circuit diagrams and other information necessary for the proper operation and maintenance of the system shall be included.
- B. All material and/or equipment necessary for the proper operation of the system, even though not specifically mentioned in the contract documents, shall be deemed part of this contract.
- C. Include operator instructions for each required mode of operation, routine troubleshooting procedures, manufacturer's operation and maintenance manual for each item of equipment and accessory, and routine cleaning methods and materials.
- D. To establish continuity in manufacturer, system components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems.

- E. The work to be provided under this Section consists of furnishing and installing all equipment, cabling, and labor required for complete, operable, new life safety communication system for the School. These systems shall be referred to as the LIFE SAFETY SYSTEM and their supplier as the LIFE SAFETY CONTRACTOR.
- F. The LIFE SAFETY CONTRACTOR must be a factory-authorized representative or distributor of all equipment used in the low voltage systems. Further, this contractor must have a minimum of five years of experience in the specific application of the equipment proposed for these systems. Provide a letter signed by an officer of the manufacturer attesting to the contractor's direct affiliation with the manufacturer.
- G. The entire installation shall comply with all applicable electrical and safety codes. The LIFE SAFETY SYSTEM and additional applicable equipment shall be tested and certified to UL/CSA 60065. Certifications shall be completed by a Nationally Recognized Testing Laboratory, (UL, CSA, TUV, etc.).
- H. All equipment with digital apparatus (microprocessors) that generate and use timing signals at a rate in excess of 9,000 pulses per second to compute and operate must meet FCC, Industry Canada regulations, and DOC CSA standards C108.8 (Electromagnetic Emissions). Any non-compliant equipment supplied or installed shall not be accepted and shall nullify the contract.

1.4 SERVICE AND MAINTENANCE

- A. The manufacturer shall provide a (5) Five Year Warranty against defects in material and workmanship. All materials shall be provided at no expense to the owner during normal working hours. The warranty period shall begin on the date of acceptance by the owner/engineer. Any warranty less than five years shall not be considered.
- B. Software service packs released from time to time shall be available to the user for the life of the product at no additional cost.
- C. The LIFE SAFETY CONTRACTOR supplying the equipment shall show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system, including replacement parts. The vendor shall be prepared to offer a service contract for the maintenance of the system after the guarantee period. The bidder shall produce evidence that they have a fully experienced and established service organization for at least five years and proven satisfactory installations during that time.
- D. The contractor shall supply up to 8 hours of onsite user training. User training shall consist of operation of all system functions and scheduling software.
- E. The user shall have access to telephone support from the manufacturer at no additional cost for the life of the product.

1.5 LIFE SAFETY SYSTEM DESIGN

- A. Only systems designed primarily as a LIFE SAFETY SYSTEM shall be considered. Life safety features shall include but not be limited to; priority based access to voice functions, emergency paging, emergency call-in, covert PC based call-in, pre-recorded emergency announcements, external and internal telephone access, integrated video surveillance, and optional district wide communication functions. Paging systems, traditional school intercom systems, or any system that does not include the above minimum features shall not be considered.

- B. The LIFE SAFETY SYSTEM shall be of a core design vintage dating from the year 2000 or later. LIFE SAFETY SYSTEMS that use designs dating from before the year 2000 shall not be considered.
- C. The LIFE SAFETY SYSTEM shall be an event driven design. LIFE SAFETY SYSTEMS using a polling method design shall not be considered.

Microcontroller

- D. The LIFE SAFETY SYSTEM shall contain a central microcontroller capable of a minimum of 500 MHz processing speed to allow for the addition of future features. LIFE SAFETY SYSTEMS with microcontrollers that run less than 500 MHz shall not be considered.
- E. The LIFE SAFETY SYSTEM shall have flash based removable storage media of a size no smaller than 1 gigabyte. It shall be possible to remove the storage media from one system to another like system with no need to adjust the configuration files. LIFE SAFETY SYSTEMS that do not use removable flash based media or do not have at least 1 gigabyte of storage shall not be considered.
- F. The LIFE SAFETY SYSTEM shall have at least 512 Megabytes of system ram. Said RAM shall be removable and upgradable. LIFE SAFETY SYSTEMS that do not use removable RAM or cannot be upgraded not be considered.

Central Cabinet

- G. The LIFE SAFETY SYSTEM shall contain natively RS232, RS485, USB, and Ethernet ports for communication to any third party system. LIFE SAFETY SYSTEMS that do not contain all of the above communication ports or require additional equipment shall not be considered.
- H. The LIFE SAFETY SYSTEM shall contain five open collectors, three dry contacts, and six general purpose inputs for third party system integration or for general panic buttons. It shall be possible to expand inputs or outputs to any number needed. LIFE SAFETY SYSTEMS not supporting the minimum inputs and outputs or able to expand to any number shall not be considered.
- I. The LIFE SAFETY SYSTEM central cabinet shall be a wall mounted. Total weight of the central cabinet shall not exceed 35 lbs. LIFE SAFETY SYSTEMS requiring floor racks or that weigh more than 35 lbs. shall not be considered.
- J. The LIFE SAFETY SYSTEM shall contain no moving parts that suffer from wear or that require maintenance. LIFE SAFETY SYSTEMS that contain moving parts shall not be considered.
- K. The LIFE SAFETY SYSTEM shall draw no more than 3.5A of current at full load including all system accessories. LIFE SAFETY SYSTEMS that draw more than 3.5A of current at full load shall not be considered.

- L. The LIFE SAFETY SYSTEM shall have integrated surge protection for all audio ports and switching/line card ports. Said surge protection shall be replaceable in the field with no need to return parts for repair. LIFE SAFETY SYSTEMS that require external surge protection shall not be considered.

Amplifiers

- M. The LIFE SAFETY SYSTEM shall use Class D digital amplifier with at least 250 Watts RMS and 300 Watts peak output. Amplifier distortion shall not exceed 0.2% at 90% load. LIFE SAFETY SYSTEMS using Class B amplifiers or amplifiers not capable of 0.2% maximum distortion shall not be considered.
- N. The Class D amplifier shall be direct drive 25V constant voltage type. LIFE SAFETY SYSTEMS using transformer based amplifiers shall not be considered.
- O. The LIFE SAFETY SYSTEM shall filter all voice signals through a Digital Signal Processor (DSP) to maximize voice intelligibility. LIFE SAFETY SYSTEMS not using a DSP shall not be considered.
- P. The LIFE SAFETY SYSTEM shall have 45 Ohm conversion modules available on a switching/line cards basis to convert the 25V audio signal to 45 Ohm for use with 45 Ohm speakers. LIFE SAFETY SYSTEMS not capable of conversion to 45 Ohm audio on a switching/line card basis shall not be considered.
- Q. The LIFE SAFETY SYSTEM amplifiers shall go to sleep thus reducing their current draw when not in use. LIFE SAFETY SYSTEMS that use amplifiers that do not reduce their current draw when not in use shall not be considered.
- R. The LIFE SAFETY SYSTEM amplifiers shall have a built in pink noise generator for testing speaker quality and audio levels. LIFE SAFETY SYSTEMS that do not contain a pink noise generator shall not be considered.

Tones

- S. The LIFE SAFETY SYSTEM shall have at least 25 tones available for bells, reminders, and other events. LIFE SAFETY SYSTEMS with less than 25 tones shall not be considered.
- T. The LIFE SAFETY SYSTEM shall support WAV type audio files. The user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announce tones, or any other system tone. LIFE SAFETY SYSTEMS not allowing users to add WAV files or do not allow for the use of WAV files for any system tone shall not be considered.

Switching/Line Cards

- U. The LIFE SAFETY SYSTEM shall support remote switching/line cards with 16 and 32 audio ports sizes available. A single central cabinet shall support up to eight 32 port cards. The switching/line card shall be powered from the central cabinet out to 2700 feet away from the central cabinet. LIFE SAFETY SYSTEMS that do not use remote switching/line cards or require additional power supplies shall not be considered.

Call Buttons

- V. The LIFE SAFETY SYSTEM shall allow for the use of normally open, normally closed, wireless, and virtual call buttons. LIFE SAFETY SYSTEMS not capable of using all of the above call button types shall not be considered.
- W. The LIFE SAFETY SYSTEM shall allow for the use of virtual call buttons installed on local PC computers. LIFE SAFETY SYSTEMS that do not support virtual call buttons shall not be considered.

Security Integration

- X. The LIFE SAFETY SYSTEM shall allow for the integration of motion sensors, glass break sensors, and door contacts in parallel with call buttons. Events from these sensors shall be capable of being programmed to activate pre-recorded WAV files, outputs, and cameras. LIFE SAFETY SYSTEMS that do not support integration of security sensors shall not be considered.

Video Surveillance

- Y. The LIFE SAFETY SYSTEM shall provide eight transmission paths and control of closed-circuit television (CCTV) UTP type cameras. LIFE SAFETY SYETEMS that do not provide camera transmission paths shall not be considered.
- Z. The LIFE SAFETY SYSTEM shall support cameras connected on the same cable as speaker/call button ports. LIFE SAFETY SYETEMS that require additional cabling for cameras shall not be considered.

1.6 LIFE SAFETY SYSTEM OPERATION

- A. The LIFE SAFETY SYSTEM shall allow for user-programmable room number assignment in the form of 3, 4, 5 or 6-digit alphanumeric format for architectural room numbering and a 60 character alpha-numeric caller ID description associated with each audio port. LIFE SAFETY SYETEMS that do not support caller-ID on all ports or require additional equipment to support caller-ID shall not be considered.
- B. The LIFE SAFETY SYSTEM shall allow for a minimum of 64 page/time/program zones that can be assigned and configured as desired. LIFE SAFETY SYSTEMS with less than 64 zones shall not be considered.
- C. The LIFE SAFETY SYSTEM shall allow for the assigning of each call-in button to one or more of 32 distinct call-in destination groups. LIFE SAFETY SYSTEMS with less than 32 call-in groups shall not be considered.
- D. The LIFE SAFETY SYSTEM administrative telephone shall allow for the user to view the alphanumeric room address and the caller-ID information of the calling station and the call priority (e.g., emergency, normal) on the display. The administrative telephone shall use distinctive ringing patterns to annunciate the type of call. LIFE SAFETY SYSTEMS that do not support caller-ID or call priority shall not be considered.

- E. The LIFE SAFETY SYSTEM shall be capable of receiving 2048 call-ins simultaneously without data collisions or loss of any call-ins. Call-ins shall remain in the system call queue until answered. Emergency Call-ins shall automatically move to the top of the call-in queue and annunciated in the in-use telephone earpiece to notify the user of an emergency call. LIFE SAFETY SYSTEMS that do not maintain a system call queue or do not prioritize call-ins shall not be considered.
- F. The LIFE SAFETY SYSTEM shall communicate with each classroom loudspeaker hands-free. The staff member or occupant in the classroom need not operate any buttons to reply to a call. The Administrative telephone operator shall be able to use the hands-free speaker phone or handset on an Administrative telephone. LIFE SAFETY SYSTEMS requiring "push to talk" shall not be considered.
- G. The LIFE SAFETY SYSTEM shall operate under the following audio priority scheme. LIFE SAFETY SYSTEMS not following the audio priority scheme listed below shall not be considered.
 - 1. An emergency page suspends all other audio
 - 2. An emergency tone suspends all other audio except the above
 - 3. A normal page suspends all other audio except the above
 - 4. A tone suspends all other audio except the above
 - 5. A program source audio event suspends nothing
 - 6. Interrupted lower priority functions shall be restored after conclusion of the higher priority function.
- H. The LIFE SAFETY SYSTEM shall allow a call-in to be escalated from a normal call-in to an emergency call-in at any time by pressing the call button twice within 2 seconds. LIFE SAFETY SYSTEMS that do not allow for call escalation shall not be considered.
- I. The LIFE SAFETY SYSTEM shall allow for any connected telephone to place an emergency voice paging announcement. LIFE SAFETY SYSTEM that restricts access to emergency paging shall not be considered.
- J. The LIFE SAFETY SYSTEM shall allow the activation of connected dormant cameras based on an emergency call-in, security sensor activation, or telephone code. LIFE SAFETY SYSTEMS not allowing for integrated emergency camera functions shall not be considered.
- K. The LIFE SAFETY SYSTEM shall allow for operation via a GUI based PC based application. The PC application shall allow for emergency paging, normal paging, intercom, activation of any system/user tone, schedule changes, program distribution, call-in management, and on the fly room exclusion. LIFE SAFETY SYSTEMS that do not support PC based control shall not be considered.
- L. The LIFE SAFETY SYSTEM shall use a PC based GUI scheduling tool for schedules and tone management. This tool shall not allow access to any system configuration controls. This tool shall not prevent the LIFE SAFETY SYSTEM from operating when being used. This tool shall allow the user to schedule events and manage tones over the local LAN/WAN and the Internet. It shall not be required to be directly connected to the central system to use this tool. LIFE SAFETY SYSTEMS that do not separate scheduling and tone functions from any other configuration functions or cannot be used over LAN/WANs or the Internet shall not be considered.
- M. The LIFE SAFETY SYSTEM shall have a built in 30 day log of every system function and access. LIFE SAFETY SYSTEMS not having a 30 day log shall not be considered.

- N. The LIFE SAFETY SYSTEM shall have a built in real time system diagnostics application. LIFE SAFETY SYSTEMS that do not have any real time system diagnostics shall not be considered.
- O. The LIFE SAFETY SYSTEM shall allow for system diagnostics, system log access firmware updates, and programming over the local LAN/WAN or over the Internet. LIFE SAFETY SYSTEMS not providing all of the above functions shall not be considered.

2.2 SYSTEM STARTUP

- A. Prior to completion of new public address system, obtain the class bell schedule from school's administrative staff and program master clock.

2.3 MAINTENANCE

- A. Rauland Telecenter System 21. The intent is to establish a standard of quality, function and features. It is the responsibility of the bidder to insure that the proposed product meets or exceeds every standard set forth in these standards. This standard represents a carefully planned communication system. The supplier shall not employ their own ideas as to design, functions or operating parameters.

2.4 PROGRAMMING:

- A. The system shall be user-programmable through an electronic keypad or administrative control center unit mounted at the cabinet to accomplish the following functions and also through a connection to a personal computer to accomplish the following functions:
 - 1. All programmable master clock functions.
 - 2. Assignment or change of classroom stations by architectural room number.
 - 3. Assignment of speaker locations to any one or more of the sixty-four zones available for paging and distribution of the time tone signals.
 - 4. Have two program sources.

2.5 MASTER CLOCK FUNCTIONS:

- A. The sound system shall have built-in master clock capacity with the following master clock functions.
 - 1. Microprocessor based master clock unit capable of full secondary clock correction and class change time tone activation.
 - 2. Capacity for storing events and holidays in nonvolatile memory.
 - 3. Ability to review, edit and delete events.
 - 4. Review of events from any entered time of day.
 - 5. Events shall be programmable to any one or all of sixty-four (64) zone circuits.
 - 6. Selection of any one of sixteen (16) (minimum) schedules to allow flexibility due to seasonal changes or special events.
 - 7. Fully automatic holiday program execution. Bells can be silenced or special events can be implemented. Normal bells will resume after the holiday period.
 - 8. User-programmable Automatic Daylight Savings Time Change.
 - 9. Ability to test all output zone circuits.
 - 10. Separate bell duration for each zone circuit.
 - 11. Permit interface to a personal computer to allow remote programming, diagnostics and call logging.

2.6 SPEAKERS

- A. Internal Ceiling Mounted Speaker:
Rauland ACC1400 with Faceplate Rauland ACC100
- B. Exterior surface wall mounted speakers shall be Atlas VT-152UCN
- C. Volume Controls: Shall be Soundolier VC-5K or Architect/Engineer approved equal, installed where indicated on the drawings.

2.7 WIRING

- A. All speaker wiring shall be 22 gage three conductor shielded or approved equal. Wiring Blocks: Telephone type punch down blocks shall be fitted with hinged covers. Siemons Series #S66M4-2W or approved equal.
- B. Remote pull boxes and /or sound system cabinets shall be screw cover with 3/4" plywood backboard painted grey. Telephone punch down blocks are to be fitted on plywood backboard. All pairs shall be labeled as to their location. Minimum size for remote pull boxes and / or sound system cabinets shall be 12" X 12" with double door construction. Minimum size main console cabinet located at the rack equipment shall be 24" X 24" with double door construction. Refer to schematic drawings located at the end of these standards for exact requirements.
- C. All cabling for this system shall be white.

PART 3 - EXECUTION:

3.1 GENERAL

- A. All final connections of the master rack or console shall be made by or under the supervision of an accredited factory engineer or his representative. It shall be the responsibility of this engineer to make this installation to the Owner's approval as far as zoning and class change schedules.

3.2 INSTALLATION

- A. Speaker Wiring Raceway: Speaker wiring shall be extended in conduit of size base on the following table unless otherwise noted:

| No. of Cables (3 conductor) | Size of conduit |
|--------------------------------|-----------------|
| 1 to 4 | 1/2" |
| 5 to 9 | 3/4" |
| 10 to 14 | 1" |
- B. To insure proper wiring of the entire public address system, the total load connected to the console shall be measured using an impedance bridge and an audio generator. The load impedance shall be measured at 400 Hz, and shall not be less than 6.5 ohms for the total load on a 25 volt line. The load is based on wiring classroom speakers at 1/2 watt (2 watts for cafeteria). Do not exceed 1/2 watt tap on speakers in areas with ceiling heights of 10 feet or less.
- C. Intermediate Junction Boxes: All intermediate and homerun junction boxes shall be complete with terminal strips and labeling of each speaker pair as to its location. This labeling shall be accomplished with linen tags or plastic Dymo-type labels. Boxes shall be screw cover with 3/4" plywood backboard, flush or surface mounted as indicated on the Drawings and

painted blue for easy identification during construction phase.

- D. Main console speaker line(s) mounting board: Provide the main console speaker mounting backboard with telephone terminal blocks, as required, with respective labeling of each speaker pair as to its origin (i.e., "Room 235", "Conference 109", etc.). The cabling shall be such that the cabling from mounting board to console may be disconnected at the mounting board in case the console has to be removed. Labeling on cables and terminal blocks must match for ease in reconnection if disconnection is ever necessary. All conductors shall be labeled as to speaker origin/location with Scotch Code STD-0-9 markers or Owner approved equal. Protect all labels with clear heat shrink tubing, Insulgrip HS 105 VW-1 or approved equal. All wiring shall be arranged in a neat and orderly manner and subject to Owner's approval.
- E. Furnish and install insulated metallic bushings at main screw cover junction box and at public address console where routing multi-conductor cables. Provide spiral wrap on multi-conductor cables extending from screw cover junction box to console for added protection.
- F. Terminate each #22 AWG drain/shield wire in addition to speaker pair wiring at telephone punch blocks. Furnish and install jumpers (daisy chain) as required to bond all speaker pair drain/shield wires together. Provide required number of telephone punch blocks to accommodate speaker pairs installed plus 20% spare. Spares are to be terminated at both ends at the terminal box.
- G. The Contractor shall provide exterior horns and corridor speakers as shown on the drawings. The horns and speakers shall all be on one zone and are to be used for paging/calling custodian or other personnel while minimizing disturbances to classrooms. Exterior signals will also be used to sound the "all-clear" signal during fire drills.
- H. Provide a 3/4" conduit with a four (4) pair telephone cable between main public address system box and telephone key equipment for connection of diagnostic feature modem.

3.3 CONSTRUCTION – INTERFACE

- A. Excavation for Conduits: Replacement of underground trunk lines where shown on the drawings shall occur over the Christmas holiday, summer break or long weekend as applicable to suit required work. Before digging, the Contractor shall field locate all existing underground improvements in the project area by calling the various utility locator services and coordinating with Owner's maintenance department. Sidewalks shall be saw cut and patched by workers experience with type of work. Patch work must provide appearance to match existing concrete finish of sidewalk. The trenches shall not be left in an unsafe condition. Provide necessary barricades to protect the open trench. Any damage to utilities in the area of excavation shall be repaired immediately at the sole expense of the contractor and without cost to the Owner.

3.4 FIELD QUALITY CONTROL

- A. The Contractor shall demonstrate the fully operational system to the Architect/Engineer and provide written certification that the system was installed in accordance with manufacturer's recommendations and tested to ensure system is fully operational and meets all of the manufacturer's performance standards.

END OF SECTION 27 51 00

SECTION 28 13 00 - ACCESS CONTROL SYSTEM

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1- GENERAL

1.1 WORK INCLUDED

- A. This specification section scope of work shall include card reader access interface and all associated wiring at locations shown on the project drawings. Provide and install all materials and devices as designated below.
 - 1. Door Access Control Panel.
 - 2. Card Readers
 - 3. Wiring from the card reader to the head end location and all door hardware
 - 4. Connections to electrified door hardware and associated power supplies
 - 5. Preconstruction meeting with Owner's personnel, installing technician and project superintendent.
- B. Interface to existing access control system. Provide all interconnection and programming required for a fully functional access control system.

1.2 CODES AND STANDARDS

The system shall comply with the applicable Codes and Standards as follows:

- A. National Fire Protection Association Standards:
 - 1. NFPA 70 National Electric Code
 - 2. NFPA 72 National Fire Alarm Code
 - 3. NFPA 101 Life Safety Code
- B. Local & State Building Codes
- C. Requirements of Local Authorities having Jurisdiction
- D. Underwriters Laboratory Requirements and Listings for use in Security Alarm Systems.
- E. Requirements of American Disabilities Act (Public law 101-336).
- F. Texas Accessibility Standards (T.A.S.)
- G. State Fire Marshall.
- H. Texas Insurance Code.

1.3 SUBMITTALS

- A. The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:
 - 1. Riser diagrams.
 - 2. Complete floor plan drawings locating all system devices.
 - 3. Factory data sheets on each piece of equipment proposed.
 - 4. Detailed system operational description. Any specification differences and deviations shall be clearly noted and marked.
 - 5. Complete system bill of material.
 - 6. Line by line specification review stating compliance or deviation.
- A. All submittal data will be in bound form with Contractor's name, supplier's name, project

ACCESS CONTROL SYSTEM

name, and state security license number adequately identified.

- B. Specification Compliance: A letter shall be provided stating, by section and subsection, that the system installer complies with the ENTIRE specification section. If the installer intends to deviate from any portion of the specifications, a detailed explanation of reason in which the installer would like to deviate shall be provided in addition to the specification compliance letter. NO DEVIATIONS SHALL BE ACCEPTABLE UNTIL THEY HAVE BEEN ACCEPTED BY THE PROJECT'S TECHNOLOGY CONSULTANT.

PART 2 – PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL AND ALARM MONITORING SYSTEM EQUIPMENT

A. Approved manufacturers:

- 1. The access control panel must be compatible with existing access control system.
- 2. The Access Control System management software and licensing must be included.

B. PROXIMITY READER

- 1. The reader shall be proximity type. It shall read the encoded data from the access card when presented to the surface of the reader without physical contact and transmit the data back to the host panel, giving an audible and visual indication of a properly read card.
- 2. Readers shall support 125kHz proximity technology.

C. DOOR POSITION SWITCHES

- 1. Provide door position switches only where indicated on floor plans with conduit run to a the nearest accessible, junction box located above ceiling.
- 2. Aluminum doors or frames (non-ferrous) flush mount: Provide recessed magnetic contact door switches.
- 3. Steel doors or frames (ferrous) flush mount: Provide recessed magnetic contact door switches.
- 4. Doors surface mount, standard duty: Provide magnetic contact door switches.
- 5. Doors surface mount, heavy duty armored: Provide magnetic contact door switches.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All wiring shall be in accordance with the National Electrical Code, Local Codes, and article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.
- B. All wire shall be UL Listed CL2 for limited energy (300V) applications and shall be installed in conduit. Limited energy MPP wire may be run open in return air ceiling plenums provided such wire is UL Listed for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 if so approved by the local authority having jurisdiction.
- C. No AC wiring or any other wiring shall be run in the same conduit as security alarm wiring.

- D. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
- E. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
- F. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
- G. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/conduit system. All riser boxes shall be adequately sized for the number of conductors transversing the respective box as well as the number of terminations required.
- H. Network Connection Cable: Provide a 4 pair Category 6 data cable from the Master Control Panel to the MDF network rack. Category 6 cable shall be Grey in color.
- I. All plenum wiring is to be installed parallel and perpendicular to the building structure. Install wiring tight up against structure for protection. Cable shall be bundled on a maximum of 2'-6" and secured to the structure at a maximum of 5' on center. Bundling and support shall be with plenum rated cable ties.
- J. Contractor is required to provide all mapping and software configuration required to operate system as per manufacturer's recommendations.
- K. Install system in accordance with manufacturer's instructions.
- L. Install wiring for detection and signal circuit conductors in conduit. Use 22 AWG minimum size conductors.
- M. Make conduit and wiring connections to existing door hardware devices as required.

3.2 CABLE PATHWAYS

- A. Cable Support:
 - 1. All wire not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system for the entire run of each cable. Including, but not limited to service loops.
 - a. Approved Cable Support Product:
 - 1. Modular support system (sized appropriately for the number of wires being installed. Reference the manufacturer's specifications for the suggested maximum cables per support size.
 - 2. The approved cable support system shall be attached directly to the building steel at a serviceable height. In the event that the building steel is not 5' of the finished ceiling, the contractor shall provide a dedicated threaded rod extending within 5' of the finished ceiling and mount the J-MOD™ support hook to the treaded rod.
 - 3. Cable support shall be installed at a maximum of 5' on center.
 - 4. All cable installed shall be attached to the J-MOD™ support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep wires neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the wires within each type of panel.
 - 5. Absolutely no cable, not installed in conduit, will be allowed to be attached directly to the building's steel or supported in any other method than that stated

ACCESS CONTROL SYSTEM

above.

6. It is the responsibility of the installing contractor to coordinate with all other trades on the project to insure that the pathway of this system does not interfere with the installation of the other trades and to prevent the installed product of other trades from putting strain on the installed wiring.

B. Conduit / Raceway:

1. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
2. Conduit and raceway system shall be installed as specified under the general electrical section of the specifications, and per NEC.
3. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
4. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
5. All conduit ends shall have a protective bushing to prevent cable damage. Bushings must be installed prior to installing cable. Cutting bushing to install around installed cables will not be accepted.

3.3 WARRANTY

- A. All provided and installed infrastructure and devices shall be warranted against defects in materials and workmanship for a period of one (1) year from the date of substantial completion.

3.4 FIELD QUALITY CONTROL

- A. Test in accordance with NFPA 72 - National Fire Alarm Code
- B. Test in accordance with manufacturer's requirements.

3.5 TRAINING

- A. The Dealer shall coordinate with the System Administrators for two 8 hour Operator training sessions on the Operational System to be conducted on-site on the actual running system.

3.6 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services for final system checkout and acceptance testing as required.

3.7 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 28 13 00

SECTION 28 16 00 – INTRUSION DETECTION SYSTEM

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED WORK

- A. 26 05 00 – Grounding and Bonding
- B. 26 05 29 – Electrical Hangers and Supports
- C. 26 05 33 – Raceway and Boxes

1.2 WORK INCLUDED

- A. The Contractor shall extend the existing Gemini Security System from the closest IDF in the existing building to the natatorium IDF. The Contractor shall furnish and install all devices depicted in the drawings to cover the intrusion detection at the natatorium. The system shall include, but not be limited to, all control equipment, power supplies, power circuits, signal initiating and signaling devices, conduit, wire, fittings, and all other accessories required to provide a complete and operable system.
- B. The system shall include security for all access into building, including but not limited to doors, roof hatches, windows and interior space motion detection. Card reader access interface must also be provided at locations noted.
 - 1. The Control System shall be the extension of the existing Gemini system.
 - 2. Tag all conductors or cables at each end.
 - 3. Installation of security panels or extender panels.
 - 4. Interconnection of security panels or extender panels.
 - 5. Installation of new security devices.
 - 6. Full coverage of all windows, doors, roof hatches.
 - 7. Preconstruction meeting with Owner's personnel, installing technician and project superintendent.
- C. The contractor shall connect this location to the district monitoring station as designated by the owner.

1.3 CODES AND STANDARDS

The system shall comply with the applicable Codes and Standards as follows:

- A. National Fire Protection Association Standards:
 - 1. NFPA 70 National Electric Code
 - 2. NFPA 72 National Fire Alarm Code
 - 3. NFPA 101 Life Safety Code
- B. Local & State Building Codes
- C. Requirements of Local Authorities having Jurisdiction
- D. Underwriters Laboratory Requirements and Listings for use in Security Alarm Systems.
- E. Requirements of American Disabilities Act (Public law 101-336).
- F. Texas Accessibility Standards (T.A.S.)
- G. State Fire Marshall.

- H. Texas Insurance Code.

1.4 QUALITY ASSURANCE

- A. Contractor Qualifications:
1. The installing contractor shall be the authorized representative of the Security Alarm and Access control system.
 2. Manufacturer to sell, install, and service the proposed manufacturer's equipment. The installing contractor shall have represented the security alarm and Access control system manufacturer's product for at least two years.
 3. The installing contractor shall be licensed by the State of Texas as a security services contractor to design, sell, install, and service security alarm systems and access control system.
 4. The installing contractor shall provide 24 hour, 365 day per year emergency service with factory trained service technicians.
 5. The installing contractor shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing security alarm systems for at least ten (10) years.
 6. All Contractors must submit to the owner prior to starting any work the factory training certificates for all personnel that will be working on the System. No person is allowed to work on the system without proper manufacturer's certification.

1.5 SUBMITTALS

- A. The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:
1. Control panel wiring and interconnection schematics.
 2. Complete point to point wiring diagrams.
 3. Riser diagrams.
 4. Complete floor plan drawings locating all system devices.
 5. Factory data sheets on each piece of equipment proposed.
 6. Detailed system operational description. Any specification differences and deviations shall be clearly noted and marked.
 7. Complete system bill of material.
 8. Line by line specification review stating compliance or deviation.
- B. All submittal data will be in bound form with Contractor's name, supplier's name, project name, and state security license number adequately identified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND INSTALLERS

- A. NAPCO Security Systems, Inc.
333 Bayview Avenue,
Amityville, NY 11701

2.2 CONTROL COMMUNICATOR (Panel)

- A. The DACS control panel shall be Gemini Security Systems, Inc. model GEM-P3200 comprising a fully integrated intrusion and residential fire control system. The control panel shall support the following:
1. The DACS system is capable of being utilized as a combination Intrusion and Commercial Fire system per code. Fully integrated intrusion and fire functions allow users to interface with 1 system instead of 2
 2. Optional Telephone Line Module, programmable for signaling and supervision.
 3. Integrated Conettix IP based communication provides high-speed, secure alarm transport and control.
 4. 32 programmable areas with perimeter and interior partitioning.
 5. 8 on-board, hardwired points with expansion capability for a total of 599 using a combination of wired or wireless points.
 6. Compatibility with Color Graphic Touch Screen, 2-line alpha numeric capacitive touch, ATM style LCD or 2-line LCD style Alarm Keypads.
 7. Local or remote programming, test, and diagnostic capability via a computer running the Remote Programming Software (RPS).
 8. The system shall include an integrated USB port for local programming and diagnostics using a computer running Remote Programming Software (RPS) and a male USB2.0 to male USB 2.0 cable with no additional hardware modules required.
 9. The system shall support the use of an Apple iOS device and/or Android device for control. Functions to include arming, disarming and control of outputs and access door, viewing of connected IP cameras. This application shall connect directly to the DACS using internet, Wi-Fi or cellular communications and shall not require a third party server or network operations center (noc).
 10. The DACS will allow integration with up to 16 IP video cameras using the built-in Ethernet connection, allowing the cameras to act as inputs and outputs.
 11. The DACS shall support integration with the Video Management System using the built-in Ethernet adapter.
 12. The DACS shall support up to thirty-two (32) custom functions allowing the installer to combine up to 6 functions into one command. These custom functions shall be operated by keypad command, point activation, key fob button, or programmable schedule
 13. The DACS shall support up to 32 keypad shortcuts which allow the installer to define which commands are available at each keypad.
 14. The system shall offer multiple language support that can be assigned per keypad. Languages supported must include English, Latin American Spanish, Portuguese and/or Canadian French.
 15. The DACS shall support flash firmware upgrades of systems firmware for the control panel and peripherals, allowing for future updates.
 16. Integrated real time clock, calendar, test timer and programmable scheduling capability for relay control and automatic execution of system functions based on a time / event.
 17. Provide 1.4 amps of power for standby operation and 2.0 amps of alarm power, both rated at 12 VDC.
 18. 3 configurable form 'C' wet or dry-contact relay outputs with expansion capability for up to an additional 472 dry-contact relay outputs.
 19. Integrated battery charger with reverse hook up protection, battery supervision and battery deep discharge protection.
 20. Supervision of peripheral devices and communications interface(s).
- B. Contractor shall provide PSTN and cellular communication modules.

2.3 FIELD DEVICES

- A. Ceiling mounted, 360-degree dual technology, infrared sensors/microwave motion sensors. Model DS 9370
 - 1. Bracket for direct mounting to standard 3-1/2" and 4" electrical back boxes.
 - 2. All units to have areas of coverage, which would cause false alarm signals to be generated, masked out and adjusted to reduce false signals.
 - 3. Contractor to provide a dedicated POPIT for each motion detector on the project.
- B. Wall mounted, high performance, TriTech PIR/Microwave sensor, Model DS970.
 - 1. Low Profile Bracket for directional mounting to standard 3-1/2" and 4" electrical back boxes.
 - 2. All units to have areas of coverage, which would cause false alarm signals to be generated, masked out and adjusted to reduce false signals.
 - 3. Provide in gymnasiums/cafeteria wall mounted areas. Provide protective wire cover in gymnasium areas.
 - 4. Contractor to provide a dedicated POPIT for each motion detector on the project.
- C. Magnetic Door/Hatch Contacts MODEL Sentrol 2500 Series 2505L
 - 1. Where exposed contacts are used, they shall be heavy duty switches protected by die cast aluminum housing. The contact leads shall be encased in steel armor jacket.
 - 2. Magnetic Door/Hatch Contacts MODEL Sentrol 2505A door contact
 - 3. Contractor to provide a dedicated POPIT for each motion detector on the project.
- D. Wall mounted Key Pad, Model B921C
 - 1. Install at locations shown on drawings.
 - 2. Provide clear, polycarbonate lockable cover.

2.4 WIRING

- A. All wiring shall be by the manufactures specifications. All cable shall be shielded as required.
- B. All 120v Power shall be furnished by the Division 26000 contractor.
- C. All Security Conduit as show on the drawings shall be furnished by the division 26000 contractor as part of their scope of work.
- D. Coordination with the Division 26000 contractor is the responsibility of the Security Contractor to ensure all conduit is in place for a complete installation.
- E. All systems shall be connected to an emergency power source as available.
- F. Color code of all security intrusion detection system and access control wiring shall be yellow in color.
Approved Products:
 - 1. 18/2 unshielded:
Tappan Wire & Cable, Inc.
 - 2. 18/2 shielded:
Tappan Wire & Cable, Inc.
 - 3. 18/4 unshielded:
Tappan Wire & Cable, Inc.
 - 4. 18/4 shielded:
Tappan Wire & Cable, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All wiring shall be in accordance with the National Electrical Code, Local Codes, and article 760 of NFPA Standard 70. All wiring sizes shall conform to recommendations of the equipment manufacturer, and as indicated on the engineered shop drawings.
- B. All wire shall be UL Listed CL2 for limited energy (300V) applications and shall be installed in conduit. Limited energy MPP wire may be run open in return air ceiling plenums provided such wire is UL Listed for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 if so approved by the local authority having jurisdiction.
- C. No AC wiring or any other wiring shall be run in the same conduit as security alarm wiring.
- D. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
- E. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
- F. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
- G. All vertical wiring and all main trunk/riser wiring shall be installed in a complete raceway/conduit system. All riser boxes shall be adequately sized for the number of conductors trans versing the respective box as well as the number of terminations required.
- H. Telephone Cable: Provide a 4 pair Category 5E telephone cable from the Master Control Panel to the Telephone Equipment Room.
- I. Each motion sensor is to be connected into a dedicated POPIT module for point identification.
- J. Each set of magnetic door contacts that protect one room are to be connected through one POPIT module for point identification of that room.
- K. Magnetic door contacts protecting separate hallways or entry areas to be connected into separate POPIT modules for separate identification.
- L. **Provide and install (1) dedicate POPIT for each device installed on the project. Including, but not limited to glass break detectors.**
- M. All POPIT Modules shall be installed inside a 4"x4" junction box with a cover. Junction box shall be mounted on the wall nearest to the device the POPIT Module is associated with and the module shall be mounted to the mounted to the back box at each location.
- N. Integrate the security system to the remote monitoring station. Provide all hardware and cabling as required. Coordinate with Owner for approved remote monitoring service.
- O. All popits on project shall be mounted above ceiling in easily accessible area. All popit modules are required to be located on as-built drawings delivered to owner at completion

INTRUSION DETECTION SYTEM

of project.

- P. All keypads and sirens shall have dedicated wiring homeruns from each keypad or siren back to panel. Do not daisy chain keypads or sirens.

3.2 CABLE PATHWAYS

- A. Cable Support:
1. All must be installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system for the entire run of each cable. Including, but not limited to service loops.
 2. NO J-HOOKS WILL BE USED.
 3. ABSOLUTELY NO CABLE, NOT INSTALLED IN CONDUIT, WILL BE ALLOWED TO BE ATTACHED DIRECTLY TO THE BUILDING'S STEEL OR SUPPORTED IN ANY OTHER METHOD THAN THAT STATED ABOVE.
 4. IT IS THE RESPONSIBILITY OF THE INSTALLING CONTRACTOR TO COORDINATE WITH ALL OTHER TRADES ON THE PROJECT TO INSURE THAT THE PATHWAY OF THIS SYSTEM DOES NOT INTERFERE WITH THE INSTALLATION OF THE OTHER TRADES AND TO PREVENT THE INSTALLED PRODUCT OF OTHER TRADES FROM PUTTING STRAIN ON THE INSTALLED WIRING.
- B. Conduit / Raceway:
1. All wire shall be installed in an approved conduit/raceway system in accordance with district standards. Maximum conduit "fill" shall not exceed 40% per NEC.
 2. Conduit and raceway system shall be installed as specified under the general electrical section of the specifications, and per NEC.
 3. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
 4. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.

3.3 SYSTEM OPERATION

- A. When an alarm condition is detected by any of the alarm initiating devices, the following functions shall occur:
1. The system keypad's interior audible device shall sound until silenced by using proper security code or after system time out.
 2. A custom system alarm message shall be displayed on the LCD display. This display will show the alarm device location in plain English. Location and partition custom messages shall be field programmable.
 3. The remote signaling tie connection shall be activated at the Owner's approved central security monitoring location and/or other Owner designated location.
 4. Printer shall provide printed copy of events recorded in logger. Install adjacent to security panel.

3.4 SYSTEM ZONING AND PARTITIONING

- A. The system shall employ intelligent initiating devices and interface devices capable of being recognized and enunciated at the main system keypad and devices partition keypad.
- B. All zoning/device locations shall be field programmable.
- C. Input control zones include but are not limited to the following:
 - 1. Main Areas

3.5 TESTING

- A. Submit a written test report from an authorized representative of the equipment manufacturer that the system has been 100% tested and approved. Final test shall be witnessed by Owner, Engineer, and Electrical Contractor and performed by the equipment supplier. Final test report must be received and acknowledged by the Owner prior to substantial completion.
- B. Provide instruction as to proper use and operation of system, for the Owner's designated personnel.

3.6 WARRANTY

- A. Entire system shall be warranted against defects in materials and workmanship for a period of one (1) year from the date of substantial completion.

3.7 SOFTWARE

- A. Provide two electronic copies of the final programming and program software to the Owner's Security Supervisor after final approval.

END OF SECTION 28 16 00

SECTION 28 23 00 - IP SURVEILLANCE CAMERA SYSTEM

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1- GENERAL

1.1 RELATED SECTIONS

- A. 26 05 00 – Grounding and Bonding
- B. 26 05 29 – Electrical Hangers and Supports
- C. 26 05 33 – Raceway and Boxes

1.2 DESCRIPTION OF WORK

- A. Provide licenses, camera equipment, new server, and any other items required. The installation shall comply with applicable codes and standards in effect at the job site and as indicated in the Specifications and Drawings.
- B. The contractor shall coordinate with other system vendors, where appropriate, to facilitate equipment installation, scheduling, protection of equipment and access to the project site in order to provide the Owner a substantially complete project in a timely manner.
- C. Contractor is responsible for coordinating all electrical work required on this project for connection of cameras, conduit, and power supplies. Contractor shall provide a complete turnkey solution and be responsible for the complete installation of a security camera system. Power requirements for the servers and in-wall conduits shall be provided by the project's electrical contractor. Any additional power requirements for power supplies and addition pathway conduits/sleeves are to be provided by the system proposing/installing contractor's licensed electrician.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. The proposing/installing contractor shall be a dealer/integrator of the VMS Manufacturer authorized to sell, install, program, train, and service the proposed manufacturers system.
 - 2. The proposing/installing contractor shall hold a valid Class B Security Contractors license issued by the State, sell, install, and service security systems.
 - 3. The proposing/installing contractor shall have the ability to provide 24 hour, 365 day per year emergency service with factory trained service technicians.
 - 4. The proposing/installing contractor shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing video surveillance systems for at least ten (10) years.
 - 5. The contractor shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein. Each contractor shall furnish with their submittal a letter from the manufacture indicating they are a dealer in good standing.
 - 6. The contractor must be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels.
 - 7. The contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of video surveillance distribution systems and have personnel who are adequately trained in the use of such tools and equipment.

8. A resume of qualifications shall be submitted with the Contractor's proposal indicating the following:
 - a. A list of five recently completed projects using the product proposed of similar type and size with contact names and telephone numbers for each.
 - b. A list of test equipment proposed for use in verifying the installed integrity of metallic cable systems on this project.
 - c. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who shall be assigned to this project.
 - d. A list of technical product training attended by the contractor's personnel that shall install the video surveillance system shall be submitted.
 - e. Any subcontractor who shall assist the video surveillance contractor in performance of this work shall have the same training and certification as the video surveillance contractor.
 9. All Contractors must submit, to the projects technology consultant, prior to starting any work the factory training certificates for all personnel that will be working on the intrusion detection system. No person is allowed to work on the system without proper manufacturer's certification.
- B. The entity providing pricing to furnish and install the system specified within this specification section and the physical installing entity of this system shall be one in the same. Absolutely no subcontracting on any portion of this system, by the system's proposing entity, will be allowed.
- C. Contractor must be a current integrator of solution in the closest major metropolitan area, have a permanent office located within 150 miles of the project, and be able to include information on current support staff to be able to service this client.
- D. The Owner's representative reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

1.4 REGULATORY REQUIREMENTS

- A. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. Local Building Code
 2. Local Electrical Code
 3. NEC National Electrical Code
- B. Other references:
1. TIA/EIA-568-A - Commercial Building Telecommunications Wiring Standard
 2. EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
 3. TIA/EIA-606 - The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 4. TIA/EIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
 5. TIA/EIA TSB 67 - Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems.
 6. ISO/IEC 11801 - Generic Cabling Standard
 7. EN 50173 - Generic Cabling Standards for Customer Premises

- C. Governing Codes and Conflicts: If the requirements of these specifications or the Project Drawings exceed those of the governing codes, regulations, and manufacturer installation requirements, then the requirements of these specifications and the drawings shall govern. However, nothing in the drawings or specifications shall be construed to permit work not conforming to all governing codes, regulations, and manufacturer installation requirements.

1.5 SUBMITTALS

A. Product Data:

1. Within fourteen (14) days of Notice to Proceed, the system installer shall furnish the following in a single consolidated submittal:
 - a. Permits: The Contractor shall obtain all required permits and provide copies to the Owner/Architect/Engineer.
 - b. Product Literature: Complete manufacturer's product literature for all cable, termination components, cable supports, cable labels, field devices, and other products to be used in the installation. In addition, whenever substitutions for recommended products are made, samples (when requested by the Owner/Designer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included. The submittal shall have some type of distinguishing marker or pointer to indicated what specific product is to be provided
 - c. Testing: Proposed system test result forms and a list of instrumentation to be used for systems testing.
 - d. Specification Compliance: A letter shall be provided stating, by section and subsection, that the system installer complies with the ENTIRE specification section. If the installer intends to deviate from any portion of the specifications, a detailed explanation of reason in which the installer would like to deviate shall be provided in addition to the specification compliance letter.
 - e. Certifications: The contractor shall submit all of the following certifications and the certifications must contain dates which are valid from the date of proposal and not expirer any sooner than 12 months after substantial completion of the project.
 - 1) Manufacturer's Authorized Dealer/Installer Certification: This certification must be held by the proposing/installing contractor and state that the proposing/installing contractor is and authorized dealer/installer of the system specified within the project specifications. The certification must have been obtained by the office that is within a 75 mile radius of the project's location.
 - 2) Installer Certification: This certification must be held by at least 25% of the, on-site, staff and be made available at the site if requested by the owner, architect, and/or project's technology consultant.
 - 3) Licenses: This includes all licenses required by the state in which the work is being performed, the federal government, local authorities having jurisdiction, and any organization in that governs the specific system

B. Shop Drawings:

1. Submit the following items, for Owner review and approval, within twenty-eight (28) Days of notice to proceed:
 - a. Proposed circuit routing and circuit grouping plan prepared by a system registered designer. The designer's certification must be current. Identifiable, separate routing shall be shown for both the station cabling and any backbone trunk cabling.
 - b. In addition to the cable routing, the submitted drawings shall indicate the following, even if the following is expected to be provided by the project's electrical or general contractor:
 - 1) Location of all control equipment and remote power sources
 - 2) Locations of all field devices and outlets
 - 3) Location of wall penetrations (all penetrations shall be sleeved and contain protective bushings at both ends)
 - 4) Location of sleeved wall pass-thru
 - 5) Size of sleeve at each location installed
 - 6) Quantity of cable passing through each sleeve
 - 7) Location of drops in each room (quantity or labeling of drops are not required in the submittal plans. Labeling shall be provided in the closeout plans and quantities shall be as per the contract documents, addendums, and issued changes. Each item shall be labeled for the type of outlet that it is)
 - 8) Conduit routing, size, quantity, and stub-up locations for any floor mounted outlets or outlets installed in casework.
 - c. Drawing Compliance: A letter shall be provided stating that the system installer complies with the ENTIRE project drawing, including all general, keyed, and notes to contractor. If the installer intends to deviate from any portion of the specifications, a detailed explanation of reason in which the installer would like to deviate shall be provided in addition to the specification compliance letter.

C. Close-out Procedures:

1. Four (4) copies of the following documents shall be delivered to the Architect/Engineer at the time of system acceptance. One (1) final copy of the same documents shall be delivered directly to the project's Technology Consultant upon final closeout of the project. The closeout submittals shall include:
 - a. Inspection and Test Reports: During the course of the Project, the Contractor shall maintain an adequate inspection system to ensure that the materials supplied and the work performed, conform to contract requirements. The Contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation, which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion.
 - b. Provide complete test reports for all cabling and devices that comprise system as outlined in this document.
 - c. Include the Name, address and telephone of the authorized factory representative with a 24-hour emergency service number.
 - d. The manual shall also include Manufacturer's data sheets and installation manuals/instructions for all equipment installed and a list of recommended spare parts.
 - e. Generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.

- f. An up-to-date record ("as-built") set of approved shop drawing prints that have been revised to show each and every change made to the structure cabling system from the original approved shop drawings. Drawings shall consist of a scaled plan of each building showing the placement of each individual item of the technical cabling system equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
- g. As-built Drawings shall include cable pathways, device locations with correct labeling, control equipment locations, remote power supply locations, cross connect locations, lightning protection locations, and MDF/IDF locations. The as-built drawings shall be prepared using AutoCad 2012 or later. Provide the Owner with electronic versions of the as-builts on CD media and (1) hard copy per binder.
- h. All drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and automatically graphically self-documented by the system.
- i. A copy of the manufacturer's warranty on the installed system.
- j. Any keys to cabinets and/or equipment and special maintenance tools required to repair, maintain, or service the system.
- k. Operating and Maintenance Instructions for all devices within the system. These instructions shall reflect any changes made during the course of construction, and shall be provided to the Owner, for their use, in a three-ring binder labeled with the project name and description. (4 copies)
- l. Upon completion of the work and at a time designated by the Architect or owner, provide formal training sessions for the Owner's operating personnel to include location, operation, and maintenance of all included systems and equipment. Provide a copy of the sign in and training sign off sheets
- m. One (1) 30" x 42" laminated floor plan sheets illustrating technology drops and cable designation. Contractor shall provide one complete floor plan sheet for each system panel and remote power supply location.

PART 2 -PRODUCTS

2.1 GENERAL

- A. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.
- B. All cameras shall be integrated into the Video Management Solution.
- C. Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the specifications. All approved equivalent products shall be published by addendum ten days prior to proposal for Architect/Engineer review.
- D. All equipment and materials used shall be standard components, regularly manufactured, regularly utilized in the manufacturer's system.
- E. All systems and components shall have been thoroughly tested and proven in actual use.
- F. All systems and components shall be provided with the availability of a toll free 24-hour technical support phone number from the manufacturer. The phone number shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge.
- G. All systems and components shall be provided with an explicit manufacturer warranty.

2.2 CABLE AND INSTALLATION

- A. All cameras to be provided under the scope of this project shall be PoE capable.
- B. All required network cable to each camera location on this project shall be provided by structured cabling system installer currently installing new system on site. Security camera contractor is responsible for providing and installing all power wiring for exterior cameras if needed. Cable shall be yellow in color for all cameras.
- C. Provide all penetrations and all conduits as necessary for installation of security camera installation.
- D. All exterior penetrations require necessary weatherproofing to avoid moisture penetration.
- E. All outdoor cable runs underground shall be rated for underground use.
- F. Provide all power circuits required for the servers and camera power supplies.
- G. Contractor shall not run any power cabling for any security equipment on rack tray system due to EMI considerations. Contractor shall provide individual cabling support for all low voltage power cabling.
- H. All cabling for entire project shall be installed at 5'-0" intervals in dedicated support system using supports such as j-hooks or saddle support systems. Cable supports will be securely attached directly to building structure. Do not attach cabling or supports to ductwork, piping, grid hangers, conduit, or equipment.

2.3 SURGE PROTECTION

- A. IP Camera system circuit surge protectors shall be mounted in a standard grounded Metallic enclosure and applied to all outdoor camera installations. A POE surge protector will be required.

2.4 VIDEO MANAGEMENT SYSTEM

- A. Storage capacity may need to be added to the existing system to cover additional cameras and the districts operation and retention rates. Contractor will calculate the remaining storage capacity of the existing server and coordinate with the district accordingly.

2.5 CAMERAS

- A. All cameras will be compatible and licensed for the existing video management server.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cable Support:
 - 1. All wire not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system for the entire run of each cable. Including, but not limited to service loops.
 - 2. All cable installed shall be attached to the support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep wires neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the

- wires within each type of panel.
- 3. Provide at least 10' of service loop at both headend and camera end for entire project.
- 4. Do not route cable through webbing or structural steel.

Conduit / Raceway:

1. All wire shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40% per NEC.
 2. Conduit and raceway system shall be installed as specified under the general electrical section of the specifications, and per NEC.
 3. Minimum conduit size shall be 3/4" EMT. Install conduit per engineered shop drawings.
 4. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
 5. All conduit ends shall have a protective bushing to prevent cable damage. Bushings must be installed prior to installing cable. Cutting bushing to install around installed cables will not be accepted.
- B. Fire Wall Penetrations: The Contractor shall avoid penetration of fire rated walls and floors wherever possible. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.
- C. Wall Penetrations: Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant.
- D. Provide three sided pre-finished metal hood and seal to wall where conduit penetrates exterior wall.
- E. Install new roof mounted conduits on portable pipe supports – (low profile type), as manufactured by Portable Pipe Hangers or Advanced Support Products. Provide roof protection pads under each support. Coordinate location and routing with design engineer prior to rough-in or installation of system.
- F. Do not install wall mounted cameras into metal fascia. Ensure they are mounted into brick, and sealed top and sides (not bottom)

3.2 WIRING INSTALLATION

- A. General:
1. Cabling between wiring closet and camera locations shall be made as individual home runs. No intermediate splices may be installed or utilized between the wiring closet and the camera location.
 2. All cable must be handled with care during installation so as not to change performance specifications.
- B. Placement: All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Owner's efficient use of their full capacity.

3.3 DOCUMENTATION

- A. Labels: The Contractor shall label all outlets using permanent machine engraved labels approved by the Owner. Label patch panels in the wiring closet to match those on corresponding camera locations. The font shall be at least one-eighth inch (1/8") in height, block. All labels shall correspond to as-builts and to final test reports.

- B. Contractor shall ensure complete typed labeling of all cameras with numbers that correspond to locations on video server. Labeling system shall correspond to the Owner's labeling system. Verify with Owner. Provide tags (black letters on white labels, plastic coated) on all cables and outlets.
- C. All cables shall be labeled at both ends with a machine label and all terminations shall be stenciled with a typed label for quick circuit identification. Labeling shall conform to TIA/EIA standard 606 and include interconnect cable identification numbers.
- D. A floor plan, clearly labeled with all numbered camera locations, shall be included in the as-built plans.

3.4 CABLE TESTING - BY MANUFACTURER'S REQUIREMENTS

- A. Notification: The Owner/Architect/Engineer shall be notified one week prior to any testing so that the testing may be witnessed.
- B. Final Acceptance: Before requesting a final acceptance, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the test procedures, test result forms and time table for all copper and fiber optic cabling.
- C. Procedures: Trained personnel shall perform all testing. Acceptance of the test procedures discussed below is predicated on the Contractor's use of the recommended products and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation shall be evaluated in the context of each of these factors.
- D. Errors: When errors are found, the source of each error shall be determined, corrected and the cable retested. All defective components shall be replaced and retested. Retest results must be entered on the test results form. All corrections shall be made prior to final acceptance test.

3.5 INSPECTION

- A. Conformance to the installation practices covered above are to be verified when completed. In some cases, the Owner/Architect/Engineer may observe before acceptance.

3.6 WARRANTY

- A. Guarantee and warrant all equipment provided for a period of 3 years following date of substantial completion, or a period equal to the stated guaranty/warranty offered by the product manufacturer, whichever is the longest in duration.
- B. Labor and all other costs as necessary to maintain the equipment in operating condition as intended by the product manufacturer after a period of 1 year shall be negotiated with the owner upon project completion.

END OF SECTION 28 23 00

SECTION 28 31 00 - ANALOG FIRE ALARM SYSTEM

SECTION ONE: GENERAL

1.1 SCOPE

This specification document provides the requirements for the installation, programming and configuration of a complete Honeywell Farenhyt Series IFP-300ECS digital protocol analog addressable fire alarm system. This system shall include, but not be limited to, system cabinet, power supply, built in Signaling Line Circuit (SLC), 160 character LCD annunciator, four programmable notification circuits, built in dual line, IP and optional cellular digital communicator associated peripheral devices, batteries, wiring, conduit and other relevant components and accessories required to furnish a complete and operational life safety system with functioning voice evacuation capabilities.

IFP-300ECS has the interconnection capability for up to 32 panels. The system has two modes of operation, multiple panels covering one larger building, or multiple independent buildings. RFP-2100 is used in a networked system where at least one IFP-2100 or IFP-300ECS is in the system. It is the same as an IFP-2100 without the display.

1.2 WORK INCLUDED

1.2.1 GENERAL REQUIREMENTS

The contractor shall furnish and install a complete 24 VDC, electrically supervised, analog addressable fire alarm system as specified herein and indicated on the drawings. The system shall include but not be limited to all control panels, power supplies, initiating devices, audible and visual notification appliances, alarm devices, and all accessories required to provide a complete operating fire alarm system with functioning voice evacuation capabilities.

1.2.2 LISTINGS

All fire alarm system equipment shall be listed for its intended purpose and be compatibility listed to assure the integrity of the complete system.

1.3 STANDARDS

The fire alarm equipment and installation shall comply with the current provisions of the following standards and shall be listed for its intended purpose and be compatibility listed to insure integrity of the complete system.

1.3.1 NATIONAL ELECTRIC CODE, ARTICLE 760

1.3.2 NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS:

| | |
|----------|---|
| NFPA 70 | National Electrical Code |
| NFPA 72 | National Fire Alarm Code |
| NFPA 101 | Life Safety Code |
| NFPA 720 | Standard for the Installation of CO Detection |

1.3.3 LOCAL AND STATE BUILDING CODES

BOCA, National Building Code, Mechanical Code, Fire Prevention Code

1.3.4 LOCAL AUTHORITIES HAVING JURISDICTION

1.3.5 UNDERWRITERS LABORATORIES INC.

All equipment shall be approved by Underwriters Laboratories, Inc. for its intended purpose, listed as power limited by Underwriters Laboratories, Inc., for the following standards as applicable:

UL 864 UOJZ Control units for Fire Protective Signaling Systems
Local Signaling Unit
Central Station Signaling Protected Premises Unit
Remote Signaling Protected Premises Unit.
Water Deluge Releasing Unit
UL 2075 CO Detectors Connected to FACP
UL 268 Smoke Detectors for Fire Protective Signaling systems.
UL 268A Smoke Detectors for duct applications
UL 217 Smoke Detectors for Single Stations
UL 521 Heat Detectors for Fire Protective Signaling systems.
UL 228 Door Holders for Fire Protective Signaling systems.
UL 464 Audible Signaling appliances
UL 1638 Visual Signaling appliances
UL 38 Manually Activated Signaling Boxes
UL 346 Waterflow indicators for Fire Protective Signaling systems.
UL 1481 Power Supplies for Fire Protective Signaling systems.

1.3.6 AMERICANS WITH DISABILITIES ACT (ADA).

All visual Notification appliances and manual pull stations shall comply with the requirements of the Americans with Disabilities Act.

1.4 GENERAL REQUIREMENTS

1.4.1 MANUFACTURERS/DISTRIBUTORS SERVICES:

1.4.1.1 The following supervision shall be provided by a factory trained service technician from the distributor of the fire alarm equipment. The technician shall be trained and shall have a minimum of two (2) years of service experience in the fire alarm industry. The technicians name shall appear on equipment submittals and a copy of his manufactures trained shall be sent to the project engineer. The technician shall be responsible for the following items:

- a. A pre installation visit to the job site to review equipment submittals and to verify the method by which the system is to be wired.
- b. During the installation the certified technician shall be on site or make periodic visits to verify installation and wiring of the system. He shall also supervise the completion of conduit rough, wires pulled into conduit and wiring rough, and ready for trim.
- c. Upon completion of wiring, final checkout and certification of the system shall be made under the supervision of this technician.

- d. At the time of the formal checkout, technician shall give operational instructions to the owner and or his representative on the system.

1.4.2 SUBMITTALS

The contractor shall submit three (3) complete sets of documentation within thirty (30) calendar days after award of the purchase order. Indicated in the document will be the type, size, rating, style, catalog number, manufacturers' names, photos, and /or catalog data sheets for all items proposed to meet these specifications. The proposed equipment shall be subject to the approval of the Architect/Engineer and no equipment shall be ordered or installed on the premises without that approval.

NOTE: DOCUMENTATION - Submittal of shop drawings shall contain at least three (3) copies of original manufacturer specification and installation instruction sheets. Subsequent information may be copies. All equipment and devices on the shop drawings to be furnished under this contract shall be clearly marked in the specification sheets.

Supplier's qualifications shall be submitted indicating years in business, service policies, warranty definitions, NICET certification, and completion of factory training program and a list of similar installations.

Contractor qualifications shall be supplied indicating years in business and prior experience with installations that include the type of equipment that is to be supplied.

The contractor shall provide hourly Service Rates, performed by a factory trained technician for this installed Life Safety System with the submittal. Proof of training and authorization shall be included with the submittal. These hourly service rates shall be guaranteed for a 1-year period.

1.4.2.1 CONTRACT CLOSE-OUT SUBMITTALS

Deliver two (2) copies of the following to the owner's representative within Thirty (30) days of system acceptance. The closeout submittals shall include:

- 1- Installation and Programming manuals for the installed Life Safety System.
- 2- Point to point diagrams of the entire Life Safety System as installed. This shall include all connected Smoke Detectors and addressable field modules.
- 3- All drawings must reflect device address as verified in the presence of the engineer and/or end user.

1.4.2.2 WARRANTY

Warranty all materials, installation and workmanship for a three (3) year period, unless otherwise specified. A copy of the manufacturer warranty shall be provided with the close out documentation.

1.4.2.3 PRODUCTS

This Life Safety System Specification must be conformed to in its entirety to ensure that the installed and programmed Life Safety System will accommodate all of the requirements and operations required by the building owner. Any specified item or operational feature not specifically addressed prior to the bid date will be required to be met without exception.

Submission of product purported to be equal to those specified herein will be considered as possible substitutes only when all of the following requirements have been met:

- 1- Any deviation from the equipment, operations, methods, design or other criteria specified herein must be submitted in detail to the specifying Architect or Engineer a minimum of ten (10) working days prior to the scheduled submission of bids. Each deviation from the

ANALOG FIRE ALARM SYSTEM

28 31 00 - 3

operation detailed in these specifications must be documented in detail, including page number and section number, which lists the system function for which the substitution is being proposed.

- 2- A complete list of such substituted products with three (3) copies of working drawings thereof shall be submitted to the approved Architect and/or Consulting Engineer not less than ten (10) working days prior to the scheduled submission of bids.
- 3- The contractor or substitute bidder shall functionally demonstrate that the proposed substitute products are in fact equal in quality and performance to those specified herein.

1.4.2.4 GENERAL EQUIPMENT AND MATERIALS REQUIREMENTS

All equipment furnished for this project shall be new and unused. All components shall be designed for uninterrupted duty. All equipment, materials, accessories, devices and other facilities covered by this specification or noted on the contract drawings and installation specification shall be best suited for the intended use and shall be provided by a single manufacturer. If any of the equipment provided under this specification is provided by different manufacturers, then that equipment shall be "Listed" as to its compatibility by Underwriters Laboratories (UL), if such compatibility is required by UL standards.

1.4.2.5 SATISFYING THE ENTIRE INTENT OF THESE SPECIFICATIONS

It is the contractor's responsibility to meet the entire intent of these specifications.

Deviations from the specified items shall be at the risk of the contractor until the date of final acceptance by the architect, engineer, and owner's representative.

All costs for removal, relocation, or replacement of a substituted item shall be at the risk of the electrical contractor.

SECTION TWO: SPECIFICATIONS

2.1 GENERAL

2.1.1 CONTROL PANEL

The fire alarm control panel (FACP) shall be the Honeywell Farenhyt Series IFP-300ECS analog addressable fire alarm control panel. The FACP must have a 6 amp power supply and be capable of expansion to a minimum of 102 total amps via bus connected expander modules that supervise low battery, loss of AC and loss of communication.

The FACP must have Day/Night sensitivity capabilities on detectors and be capable of supporting up to 300 analog addressable points. This shall be accomplished via signaling line circuits (SLC) capable of supporting a minimum of 159 detectors and 159 module devices each. The main panel will contain one SLC circuit with the option of utilizing a 6815 expander module. The communication protocol on the SLC loop must be digital.

The FACP must be capable of being networked to create a virtual system that is larger than 300 addressable points. The FACP network must support up to 32 FACP's on the network providing a maximum addressable point capacity of 65,400 points (IFP-2100 capacity $2,100 \times 31 = 65,100$ + IFP-300 capacity $300 = 65,400$).

The FACP must support a minimum of four programmable notification circuits. The panel must have a built in 160 character LCD annunciator with the capability of having an additional supervised remote annunciators connected in the field.

The FACP must have a built in UL approved IP and digital communicator with the option of adding a cellular module for communications. The communicator must allow local and remote up/downloading of system operating options, event history, and detector sensitivity data.

The FACP must automatically test the smoke detectors in compliance with NFPA standards to ensure that they are within listed sensitivity parameters and be listed with Underwriters Laboratories for this purpose.

The FACP must compensate for the accumulation of contaminants that affect detector sensitivity. The FACP must have day/night sensitivity adjustments, maintenance alert feature (differentiated from trouble condition), detector sensitivity selection, auto-programming mode (Jumpstart) and the ability to upgrade the core operating software on site or over the telephone.

The FACP shall have a Jumpstart feature that can automatically enroll all properly connected accessories into a functional system. Panels that do not have these capabilities will not be accepted.

The main communication bus (S-BUS RS485) shall be capable of class A or class B configuration with a total Bus length of 6,000 feet.

2.1.2 WIRING

The Signaling Line Circuit (SLC) and Data Communication Bus (S-BUS) shall be wired with standard NEC 760 compliant wiring, no twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be capable of accepting 12-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC) and also comply with article 760 of the NEC.

2.1.3 SIGNALING LINE CIRCUITS

Each SLC shall be capable of a wiring distance of 5,000 feet from the SLC driver module (6815) and be capable of supporting 159 detectors and 159 addressable module devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC in under 10 seconds. The auxiliary 6815 SLC loop module must be capable of being located up to 6000 feet from the FACP on an RS-485 bus, which is separate from the SLC bus. The SLC shall be capable of functioning in a class A or class B configuration.

2.1.4 SLC LOOP DEVICES

Devices supported must include analog photoelectric, analog heat detectors, addressable input modules, relay output modules or addressable notification modules. There is to be no limit to the number of any particular device type up to the maximum of 159 detectors and 159 addressable modules that can be connected to the SLC.

2.1.5 ANALOG DETECTOR FUNCTIONS

The products of combustion detectors must communicate analog values using a digital protocol to the control panel for the following functions:

Automatic compliance with NFPA 72 standards for detector sensitivity testing

Drift compensation to assure detector is operating correctly

Maintenance alert when a detector nears the trouble condition

Trouble alert when a detector is out of tolerance

Alert control panel of analog values that indicate fire.

2.1.6 SENSITIVITY FUNCTION

The FACP shall have the ability to set three different sensitivity levels. A zone can be programmed to a day and a night sensitivity value. The day/night schedule shall allow for 16 holiday dates that are user programmable to allow the FACP to respond at the night level on those days.

2.1.7 PROGRAMMABLE NOTIFICATION CIRCUITS

The FACP shall support four programmable notification circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable, door holder power or sounder base synchronization. The circuits can be configured as four Class B outputs, two Class B and one Class A outputs or two Class A outputs.

2.1.8 ADDRESSABLE NOTIFICATION MODULE

The contractor shall furnish and install where indicated on the plans, addressable notification modules, Honeywell Farenhyt Series Model IDP-CONTROL or SK-CONTROL. The modules shall be U.L. listed compatible with Honeywell Farenhyt Series IFP-300ECS fire alarm control panel. The notification module must provide one class A (Style Z) or class B (Style Y) notification output with one auxiliary power input. The notification module must be suitable for mounting in a standard 4 square electrical box and must include a plastic cover plate. The notification module must provide an LED that is visible from the outside of the cover plate. The notification module must be fully programmable for such applications as required by the installation. The IDP-CONTROL or SK-CONTROL shall reside on the SLC loop and can be placed up to 5,000 feet from the control or 6815 SLC loop module.

2.1.9 ANNUNCIATORS

The main control must have a built in annunciator with a 160-character LCD display and feature LED's for Alarm, Supervisory, Trouble, Silenced and Power. When in the normal condition the LCD shall display time and date based on a 200 year clock which is capable of automatic daylight savings time adjustments. All controls and programming keys are silicone mechanical type with tactile and audible feedback. Keys have a travel of .040 in. No membrane style buttons will be permissible. The annunciator must be able to silence and reset alarms. The annunciators must have twenty levels of user codes that will allow the limitation of operating system programming to authorized individuals.

2.1.10 REMOTE ANNUNCIATORS

The fire system shall be capable of supporting remote annunciators. LCD Remote annunciator, Model RA-2000, shall have the same control and display layout so that they match identically the built in annunciator. Remote annunciators shall be available in two colors, red and light gray. Remote annunciators shall have the same functionality and operation as the built-in annunciator. All annunciators must have 160-character LCD displays and must feature five LED's for Alarm, Supervisory, Trouble, Silenced, and Power. All controls and programming keys are silicone mechanical type with tactical and audible feedback. Keys shall have a travel of .040 inches. No membrane style buttons will be permitted.

The annunciator must be able to silence and reset alarms. The annunciator must have twenty levels of user codes that will limit the operating system programming to authorized individuals. The control panel must allow all annunciators to accommodate multiple users input simultaneously. Remote annunciators shall be capable of operating at a distance of 6,000 feet from the main control panel on unshielded, non-twisted cable.

2.1.11 I/O LED DRIVER MODULE

The fire system shall be able to support a minimum of eight I/O modules (SK5880) that shall be used to drive remote LED graphic style displays and accommodate up to eight dry contact type switch inputs. The I/O modules shall each drive up to 40 LEDs without requiring external power connections. The I/O module inputs shall be supervised and be suitable for alarm and trouble circuits as well as reset and silence switches. The system shall also support up to 40 LED drivers that reside on the two-wire SLC loop. These driver boards shall contain 80 LED outputs that are powered by an external power source.

2.1.12 SERIAL/PARALLEL INTERFACE

The fire system shall be capable of supporting up to two serial / parallel interfaces (SK5824) that are capable of driving standard computer style printers. The interface shall be programmable as to what information is sent to it and shall include the ability to print out Detector Status by point, Event History by point and System Programming.

2.1.13 DISTRIBUTED POWER MODULE

The contractor shall supply power modules, Models RPS-1000 and 5496, compatible with the IFP-300 fire alarm control panel. The RPS-1000 power module must have 6 amps of output power, six Flexput™ circuits rated at 3amps each, and two form C relay circuits rated at 2.5 amps at 24 volts DC. The six Flexput™ circuits shall be capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be programmable as input circuits in class A or B configurations to support dry contact or compatible two wire smoke detectors.

The RPS-1000 shall be capable of being connected via an RS-485 system bus (SBUS) at a maximum distance of 6,000 feet from the main control panel. The RPS-1000 shall contain an additional RS-485 bus that is completely compatible with all IFP-300 add on modules; including 6815 SLC expanders, RA-2000-SK5865-SK5880 annunciators, 5824 serial/parallel module and addressable devices. The RPS-1000 will also act as a bus repeater so that additional RS-485 (modules) devices can be connected at a maximum distance of 6,000 feet from the power module.

The 5496 power module must have 6 amps of output power and four circuits rated at 3 amps each. The four circuits can be programmed as notification outputs or auxiliary power outputs of door holder, constant and resettable types.

2.1.14 DIGITAL COMMUNICATOR

The digital/IP communicator must be an integral part of the control panel and be capable of reporting all zones or points of alarm, supervisory, and trouble as well as all system status information such as loss of AC, low battery, ground fault, loss of supervision to any remote devices with individual and distinct messages to a central station or remote station. The communicator must also be capable of up/downloading of all system programming options, event history and detector sensitivity compliance information to a PC on site or at a remote location.

The communicator shall transmit the information by one or more of the following means of communication – internet, cellular or standard telephone lines. The communicator must be capable of reporting via SIA and Contact ID formats. The communicator shall have a delayed AC loss report function which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. No controls that use external modems for remote programming and diagnostics shall be accepted.

2.1.15 DRY CONTACTS

The FACP will have three form “C” dry contacts, one will be dedicated to trouble conditions, the other two will be programmable for alarm, trouble, sprinkler supervisory, notification, pre-alarm, waterflow, manual pull, aux. 1 or aux. 2. The trouble contact shall be normal in an electrically energized state so that any total power loss (AC and Backup) will cause a trouble condition. In the event that the Microprocessor on the FACP fails the trouble contacts shall also indicate a trouble condition.

2.1.16 GROUND FAULT DETECTION

A ground fault detection circuit, to detect positive and negative grounds on all field wiring. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground fault will not interfere with the normal operation, such as alarm, or other trouble conditions.

2.1.17 OVER CURRENT PROTECTION

All low voltage circuits will be protected by microprocessor controlled power limiting or have a self-restoring polyswitches for the following: smoke detector power, main power supply, indicating appliance circuits, battery standby power and auxiliary output.

2.1.18 TEST FUNCTIONS

A “Lamp Test” or “Indicator Test” mode shall be a standard feature of the fire alarm control panel and shall test all LED’s and the LCD display on the main panel and remote annunciators.

A “Walk Test” mode shall be a standard feature of the fire alarm control panel. The walk test feature shall function so that each alarm input tested will operate the associated notification appliance for two seconds. The FACP will then automatically perform a reset and confirm normal device operation. The event memory shall contain the information on the point tested. The zone tripped, the zone restore and the individual points return to normal.

A "Fire Drill" mode shall allow the manual testing of the fire alarm system notification circuits. The "Fire Drill" shall be capable of being controlled at the main annunciator, remote annunciators and via a remote contact input.

A "Bypass Mode" shall allow for any point or NAC circuit to be bypassed without effecting the operation of the total fire system.

2.1.19 REMOTE INPUT CAPABILITIES

The control panel shall have provisions for supervised switch inputs for the purpose of Alarm reset and Alarm and trouble restore.

2.1.20 NOTIFICATION APPLIANCE MAPPING STRUCTURE

All notification circuits and modules shall be programmable via a mapping structure that allows for a maximum of 999 output groups. Each of these groups shall have the ability to be triggered by any of the panels 999 Zones. A zone may trigger from groups individually, or may contain a global trigger for manual pull stations, fire drills and two different system alarms. Additionally each Zone will individually control the cadence pattern of each of the Groups that it is "Mapped" to so that sounders can indicate a variety of conditions. The Zone shall be capable of issuing a different cadence pattern for each of the Groups under its control. The mapping structure must also allow a group to be designated to "ignore cadence" for use with strobes and other continuous input devices. Zones shall have eight different output categories; Detector alarm, Trouble, Supervisory, Pre-alarm, Waterflow, Manual pull, Zone Auxiliary one and Zone Auxiliary two. The patterns are; March code, ANSI 3.41, Single Stroke Bell Temporal, California code, Zone 1 coded, Zone 2 coded, Zone 3 coded, Zone 4 coded, Zone 5 coded, Zone 6 coded, Zone 7 coded, Zone 8 coded, Custom output pattern 1, Custom output pattern 2, Custom output pattern 3, Custom output pattern 4, and Constant. Each NAC circuit can also be configured to produce one of four synchronization patterns: AMSECO synchronization, Gentex synchronization, System Sensor synchronization, and Wheelock synchronization. This mapping/cadence pattern shall be supported by all system power supplies and Notification Expander Modules. This mapping/cadence pattern shall be supported by all system power supplies and Notification Expander Modules.

2.1.21 DOWNLOADING SOFTWARE

The fire alarm control panel must support up/downloading of system programming from a Windows based PC. The FACP must also be able to download the detector sensitivity test results and a 1000 event system event buffer to the PC. Communication shall take place over a direct connection to the PC and/or via the same telephone lines as the built in digital communicator and shall not require an external modem to be connected to the panel. The downloading software shall contain a code that will block unauthorized persons from accessing the panel via direct connection or over the phone lines.

2.1.22 ENGLISH LANGUAGE DESCRIPTIONS

The FACP shall provide the ability to have a text description of each system device, input zone and output group on the system. The use of individual lights to provide descriptions will not be acceptable.

2.2 SYSTEM OPERATION

2.2.1 ALARM

When a device indicates any alarm condition the control panel must respond within 10 seconds. The General Alarm or Supervisory Alarm LED on the annunciator(s) should light and the LCD should prompt the user as to the number of current events. The alarm information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.

When the alarmed device is restored to normal, the control panel shall be required to be manually reset to clear the alarm condition, except that the alarms may be silenced as programmed.

An alarm shall be silenced by a code at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur (subsequent alarm feature). When alarms are silenced the silenced LED on the control panel, and on any remote annunciators shall remain lit, until the alarmed device is returned to normal

2.2.2 TROUBLES

When a device indicates a trouble condition, the control panel System Trouble LED should light and the LCD should prompt the user as to the number of current events. The trouble information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.

When the device in trouble is restored to normal, the control panel shall be automatically reset, the trouble restore information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators. A trouble shall be silenced by a code or at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur.

2.2.3 SUPERVISION METHODS

Each SLC loop shall be electrically supervised for opens and ground faults in the circuit wiring, and shall be so arranged that a fault condition on any loop will not cause an alarm to sound. Additionally, every addressable device connected to the SLC will be supervised and individually identified if in a fault condition. The occurrence of any fault will light a trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.

Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.

SECTION THREE: SYSTEM COMPONENTS

3.0 CONTROL UNIT

3.1 SYSTEM CABINET

3.1.1 MOUNTING

The system cabinet shall be red and can be either surface or flush mounted. The cabinet door shall be easily removable to facilitate installation and service.

3.1.2 AUDIBLE SYSTEM TROUBLE SOUNDER

An audible system trouble sounder shall be an integral part of the control unit. Provisions shall also be provided for an optional supervised remote trouble signal.

3.2 POWER SUPPLY AND CHARGER:

The entire system shall operate on 24 VDC, filtered switch mode power supply with the rated current available of 6 Amps. The FACP must have a battery charging circuit capable of complying with the following requirements:

Sixty (60) hours of battery standby with five (5) minutes of alarm signaling at the end of this sixty (60) hour period (as required per NFPA 72 remote station signaling requirements) using rechargeable batteries with automatic charger to maintain standby gel-cell batteries in a fully charged condition.

OR

Twenty-four (24) hours of battery standby with five (5) minutes of alarm signaling at the end of this twenty-four (24) hour period (as required per NFPA 72 central station signaling requirements) using rechargeable batteries with automatic charger to maintain gel-cell batteries in a fully charged condition.

The power supply shall comply with U.L. Standard 864 for power limiting.

The FACP will indicate a trouble condition if there is a loss of AC power or if the batteries are missing or of insufficient capacity to support proper system operation in the event of AC failure. A "Battery Test" will be performed automatically every minute to check the integrity of the batteries. The test must disconnect the batteries from the charging circuit and place a load on the battery to verify the battery condition.

In the event that it is necessary to provide additional power one or more of the Model RPS-1000 or 5496 distributed power modules shall be used to accomplish this purpose.

3.2.1 CONNECTIONS AND CIRCUITS

Connections to the light and power service shall be on a dedicated branch circuit in accordance with the National Fire Alarm Code NFPA 72, National Electrical Code (NEC) NFPA 70, and the local authority having jurisdiction (AHJ). The circuit and connections shall be mechanically protected.

A circuit disconnecting means shall be accessible only to authorized personnel and shall be clearly marked "FIRE ALARM CIRCUIT CONTROL".

SECTION FOUR: ACCESSORY COMPONENTS

4.1 THE FACP SHALL SUPPORT THE FOLLOWING DEVICES ON THE RS-485 DATA BUS:

| | |
|----------|--|
| 6815 | Signaling Line Circuit Expander (SLC) Module |
| 5824 | Printer Interface Module |
| RA-2000 | LCD Remote Annunciator |
| 5865-3 | LED Remote Annunciator |
| 5865-4 | LED Remote Annunciator with reset and silence switches |
| 5880 | LED I/O module |
| RPS-1000 | Intelligent Distributed Power Module |
| 5496 | Intelligent Distributed Power Module |

4.2 THE FACP SHALL SUPPORT THE OPERATION OF 159 DETECTORS AND 159 ADDRESSABLE MODULE TOTAL DEVICES PER SLC LOOP WITHOUT REGARD TO DEVICE TYPE.

The following devices shall be supported:

| | |
|----------------|--|
| IDP-PHOTO | Addressable Photoelectric Smoke detector |
| IDP-PHOTO-T | Addressable Photoelectric Smoke detector with Thermal |
| IDP-PHOTOR | Addressable Photoelectric Smoke detector with Relay |
| IDP-FIRE-CO | Addressable Combination Photoelectric and CO Detector |
| IDP-HEAT | Addressable Heat Sensor |
| IDP-HEAT-ROR | Addressable Heat with Rate of Rise |
| IDP-HEAT-HT | Addressable Heat High temp 190° |
| IDP-ACCLIMATE | Addressable Multi Criteria Smoke detector with thermal |
| IDP-6AB | 6" detector base |
| DNR | Addressable Duct Detector Housing |
| IDP-RELAY | Addressable Relay Module |
| IDP-RELAY-6 | Addressable Multi Relay Module |
| IDP-RELAYMON-2 | Addressable Relay/Input Module |
| IDP-MONITOR | Addressable Input Module (Class A or B) |
| IDP-MINIMON | Mini Input Module |
| IDP-MONITOR-2 | Addressable Dual Input Module |
| IDP-MONITOR-10 | Addressable Multi Input Module (10) |
| IDP-CONTROL | Addressable Notification Module |
| IDP-CONTORL-6 | Addressable Notification Multi Module (6) |
| IDP-ZONE | Two Wire Smoke Detector Module |
| IDP-ZONE-6 | 6 Multi Smoke Detector Module |
| IDP-ISO | Isolation Module |
| IDP-BEAM | Addressable Beam Detector |
| IDP-BEAM-T | Addressable Beam Detector with Test feature |
| B224BI | Addressable Isolator base |
| B224RB | Detector Relay Base |
| B200S | Intelligent Detector Sounder Base |
| B200S-LF | Intelligent Detector Low Frequency Sounder Base |
| RTS151KEY | Remote Test Switch for Photoelectric Duct Detector |
| RTS151 | Remote Test Switch for Photoelectric Duct Detector |
| IDP-Pull-SA | Addressable Single Action Pull Station |
| IDP-Pull-DA | Addressable Dual Action Pull Station |
| ISO-6 | 6 Multi Isolation Module |

OR

| | |
|----------------|--|
| SK-PHOTO | Addressable Photoelectric Smoke detector |
| SK-PHOTO-T | Addressable Photoelectric Smoke detector with Thermal |
| SK -PHOTOR | Addressable Photoelectric Smoke detector with Relay |
| SK -FIRE-CO | Addressable Combination Photoelectric and CO Detector |
| SK -HEAT | Addressable Heat Sensor |
| SK -HEAT-ROR | Addressable Heat with Rate of Rise |
| SK -HEAT-HT | Addressable Heat High temp 190° |
| SK -ACCLIMATE | Addressable Multi Criteria Smoke detector with thermal |
| SK -6AB | 6" detector base |
| SK-DUCT | Addressable Duct Detector Housing |
| SK -RELAY | Addressable Relay Module |
| SK -RELAY-6 | Addressable Multi Relay Module |
| SK -RELAYMON-2 | Addressable Relay/Input Module |
| SK -MONITOR | Addressable Input Module (Class A or B) |
| SK -MINIMON | Mini Input Module |
| SK -MONITOR-2 | Addressable Dual Input Module |
| SK -MON-10 | Addressable Multi Input Module (10) |
| SK-CONTROL | Addressable Notification Module |
| SK -CONTORL-6 | Addressable Notification Multi Module (6) |
| SK -ZONE | Two Wire Smoke Detector Module |
| SK -ZONE-6 | 6 Multi Smoke Detector Module |
| SK -ISO | Isolation Module |
| SK -BEAM | Addressable Beam Detector |
| SK -BEAM-T | Addressable Beam Detector with Test feature |
| B224BI | Addressable Isolator base |
| B224RB | Detector Relay Base |
| B200S | Intelligent Detector Sounder Base |
| B200S-LF | Intelligent Detector Low Frequency Sounder Base |
| RTS151KEY | Remote Test Switch for Photoelectric Duct Detector |
| RTS151 | Remote Test Switch for Photoelectric Duct Detector |
| SK -Pull-SA | Addressable Single Action Pull Station |
| SK -Pull-DA | Addressable Dual Action Pull Station |

The FACP shall support these other Honeywell devices via addressable input, addressable notification, or addressable output modules.

| | |
|----------|--|
| PS-DALOB | Dual Action Manual Pull Outdoor Listed |
| PS-DAH | Dual Action Manual Pull Hex Key reset |
| PS-SATK | Single Action Manual Pull Station – Key Reset |
| PS-DATK | Dual action Manual Pull Station – Key Reset |
| PS-DASP | Dual action Manual Pull Station “Spanish”- Key reset |
| SB-I/O | Surface mount back box for outdoor use. |

4.3 FURNISH AND INSTALL, WHERE SHOWN ON THE DRAWINGS, THE FOLLOWING DEVICES

4.3.1 MANUAL FIRE ALARM STATIONS

Manual fire alarm stations shall be non-coded, break glass, single or double action type, with a key operated test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal except by use of a key. The reset key shall be so designed that it will reset manual station and open FACP without use of another key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of fifty feet, front or side. Manual stations shall be constructed of die cast metal

ANALOG FIRE ALARM SYSTEM

or polycarbonate with clearly visible operating instructions on the front of the stations in raised letters. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single-gang box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) dependent on manual station accessibility or per local requirements. Manual stations shall be addressable models IDP-PULL-DA / IDP-PULL-SA or SK-PULL-DA / SK-PULL-SA or installed in conjunction with an addressable input module, IDP-MONITOR / IDP-MINIMON or SK-MONITOR / SK-MINIMON. Manual stations shall be Honeywell Underwriters Laboratories listed.

All manual fire alarm pull stations must be installed with an STI stopper 2 pull station cover (PN-STI-1100)

4.3.2 REMOTE POWER SUPPLIES

The remote power supplies for notification appliances shall be the Model RPS-1000 or 5496. The Model RPS-1000 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-300 control. The RPS-1000 will support 6 amps of 24 volt DC power, with 6 Flexput™ circuits, rated at 3 amps each. Two additional 6815 SLC loop expanders shall be capable to be installed in the cabinet. The power supply will also regenerate the S-Bus for an additional 6000'.

The 5496 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-2100ECS. It will support 6 amps of 24 volt DC power with 4 notification circuits, rated at 3 amps each.

The remote power supply model 5499 or 5495 may also be used on the system. These power supplies are activated by the IDP-CONTROL module and support 24VDC power, with 4 notification circuits, rated at 3 amps each. The total power on a 5495 is 6 amps. The total power on a 5499 is 9 amps. These power boosters may also be activated from another notification circuit from either the fire alarm control, a distributed power supply (RPS-1000).

4.4 NOTIFICATION DEVICES

The visual and audio/visual signaling devices shall be compatible with the IFP-300, RFP-2100, 5495, 5496, 5499, or RPS-1000 as stated in the installation manuals and be listed with Underwriters Laboratories Inc. per UL 1971 and/or 1638. Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition. The notification appliance (combination audio/visual units only) shall produce a peak sound output of 90dba or greater as measured in an anechoic chamber. The appliance shall be capable of meeting the candela requirements of the blueprints presented by the Engineer and ADA. The appliance shall be polarized to allow for electrical supervision of the system wiring. The unit shall be provided with terminals with barriers for input/output wiring and be able to mount a single gang or double gang box or double workbox with the use of an adapter plate. The unit shall have an input voltage range of 19-30 volts.

4.5 SMOKE DETECTORS

Smoke detectors shall be Honeywell Farenhyt Series Model IDP-PHOTO or SK-PHOTO, analog/addressable photoelectric smoke detectors. The combination detector head and twist lock base shall be U.L. listed compatible with the Honeywell IFP-300 fire alarm control panel. The base shall permit direct interchange with Honeywell's IDP-ACCLIMATE / IDP-HEAT detectors or SK-ACCLIMATE / SK-HEAT detectors. The base shall be the appropriate twist lock base B210LP. The smoke detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by

actuating the control panel's reset switch. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test equipment. The vandal security-locking feature shall be used in those areas as indicated on the drawing. The locking feature shall be field selectable when required. It shall be possible to perform a sensitivity test of the detector without the need of generating smoke. The test method shall simulate the effects of products of combustion in the chamber to ensure testing of the detector circuits. Detectors shall have completely closed back to restrict entry of dust and air turbulence and have a 30 mesh insect screen. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

4.6 HEAT DETECTORS

Furnish and install analog/addressable heat detectors, Honeywell model IDP-HEAT or SK-HEAT. The combination heat detector and twist lock base shall be U.L. listed compatible with the Honeywell IFP-300 fire alarm control panel. The base shall permit direct interchange with the Honeywell Farenhyt Series IDP-PHOTO / IDP-ACCLIMATE or SK-PHOTO / SK-ACCLIMATE detectors. The base shall be appropriate twist lock base B210LP. The heat detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The vandal security-locking feature shall be used in those areas as indicated on the drawings. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

4.7 DUCT DETECTORS

Duct Detector shall be Honeywell Farenhyt Series Model DNR Duct Detector Housing. A separate IDP-PHOTO / IDP-PHOTOR or SK-PHOTO / SK-PHOTOR is required. The duct detector housing shall be capable of housing the IDP-RELAY or SK-RELAY module for optional output devices.

4.8 WIRELESS DEVICE FIRE ALARM PANEL CONNECTIVITY

Wireless devices used as components of a fire alarm system shall be capable of connection to the IFP-300 via a Signaling Line Circuit (SLC) via a gateway. The gateway shall provide the link to one mesh network of wireless devices. Multiple gateways can be supported on the same IFP-300, limited to (4) wireless mesh networks in the same radio space. All sensing functions supported for wired devices shall be supported by comparable wireless devices. Additionally, the panel shall allow wired devices to be identified with unique type codes which allow the system to display wireless trouble indications such as low battery, jamming, and tamper.

4.8.1 WIRELESS RELIABILITY

Wireless communication for the wireless system shall incorporate an advanced mesh technology which incorporates UL 864 Class A approved supervised, redundant communication. All devices in the mesh network shall be capable of acting as repeaters for other devices in the same network. The wireless system shall also have a suite of tools that can be installed on a portable PC and used to assist in qualifying the site, installing the system, and verifying the proper operation of the system.

4.8.2 WIRELESS APPROVALS

The wireless system shall be approved or listed by the following agencies, as appropriate for each device:

UL
FM
CSFM
FCC

4.8.3 ADDRESSABLE WIRELESS DEVICES

The system shall be capable of supporting addressable wireless detectors, monitor modules, and relay modules with similar appearance and capabilities as wired addressable devices.

Wireless devices shall utilize a gateway device to communicate with the fire alarm control panel, so that the wireless devices report to the panel using the established SLC protocol.

Wireless devices shall be capable of co-existing on the same panel with wired devices, and shall be capable of participating in software zone programming.

Device addressing for wireless device shall be consistent with wired devices, and shall use decade, decimal address switches.

Wireless devices (except the gateway) shall operate on batteries recommended by the manufacturer, and shall be UL tested and listed for 2 years of operation on one set of batteries.

The gateway shall be connected to the panel SLC loop and shall be capable of being powered by the SLC loop as well. Alternately, the gateway shall be capable of connection to the SLC loop only for communication with the FACP, and power may be supplied via a separate 24VDC input.

Wireless devices shall be connected to a compatible fire alarm system, and shall be supported by the system as wireless devices. Trouble conditions that are unique to wireless devices shall be reported to the FACP built-in annunciator and all connected remote annunciators.

Wireless devices shall use a UL approved Class A mesh communication protocol to provide redundant supervised wireless communication links.

A wireless mesh shall be comprised of one gateway and from one to forty-eight wireless devices.

Multiple wireless gateway systems may be connected to a single FACP.

The system shall allow for up to four wireless gateway systems in the same radio space.

Device status indicators (LEDs) on wireless devices shall not be required to match indications of wired devices, in particular for active indications where a steady on LED would reduce the battery life of the device.

Wireless detectors shall have dedicated bases with a magnetic tamper mechanism that initiates a trouble when the device is removed from the base. The tamper trouble condition shall latch at the panel until the detector is restored to the normal installed position and the trouble has been reset.

Wireless monitor modules shall have a dedicated cover that requires unfastening two screws to remove. The cover shall have a built-in magnet, and removal of the cover shall initiate a trouble condition at the panel. The tamper trouble condition shall latch at the panel until the monitor module is restored to the normal installed position and the trouble has been reset.

Wireless monitor modules shall be capable of being mounted in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. The optional surface mount Lexan enclosure shall be used for this purpose, except where installation of the wireless monitor module in a metal box has been tested and adequate performance for the application using the metal box has been confirmed.

Available Wireless devices shall include:

- WIDP-PHOTO Wireless Photoelectric Smoke Detector
- WIDP-ACCLIMATE Wireless Multi-Criteria Photoelectric Smoke Detector
- WIDP-HEAT-ROR Wireless Heat Rate of Rise Detector
- WIDP-HEAT Wireless Fixed Heat Detector
- WIDP-MONITOR Wireless Monitor Module
- WIDP-RELAY Wireless Relay Module
- WIDP-WGI Wireless Gateway Module
- B210W 6" Wireless Base

OR

- WSK-PHOTO Wireless Photoelectric Smoke Detector
- WSK-PHOTO-T Wireless Photoelectric Smoke w/Fixed Heat Detector
- WSK-HEAT-ROR Wireless Heat Rate of Rise Detector
- WSK-HEAT Wireless Fixed Heat Detector
- WSK-MONITOR Wireless Monitor Module
- WSK-RELAY Wireless Relay Module
- WSK-WGI Wireless Gateway Module
- B210W 6" Wireless Base

Un-programmed wireless devices shall be capable of being used to perform a site survey to assist in determining the viability of a site for a wireless application. Tests shall include point to point connectivity, and a background RF Scan.

A program that supports qualification of potential wireless applications, configuration and installation, and diagnostics shall be available. This program shall be installed on a Windows® PC, and shall be capable of communicating with wireless devices by use of a USB adapter that plugs into the computer.

SECTION FIVE: WIRING

5.1 INSTALLER'S RESPONSIBILITIES

The installer shall coordinate the installation of the fire alarm equipment.

All conductors and wiring shall be installed according to the manufacturer's recommendations.

It shall be the installer's responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.

5.2 INSTALLATION OF SYSTEM COMPONENTS

System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, the requirements of the fire department and other applicable authorities having jurisdiction (AHJ).

All wire used on the fire alarm system shall be U.L. Listed as fire alarm protection signaling circuit cable per National Electrical Code, Articles 760.

SECTION SIX: WARRANTY AND FINAL TEST

6.1 GENERAL

The contractor shall warrant all equipment and wiring free from inherent mechanical and electrical defects for one year (365 days) from the date of final acceptance.

6.2 FINAL TEST

Before the installation shall be considered completed and acceptable by the awarding authority, a test of the system shall be performed as follows:

The contractor's job foreman, a representative of the owner, and the fire department shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel.

At least one half of all tests shall be performed on battery standby power.

Where application of heat would destroy any detector, it may be manually activated.

The communication loops and the indicating appliance circuits shall be opened in at least two (2) locations per circuit to check for the presence of correct supervision circuitry.

When the testing has been completed to the satisfaction of both the contractor's job foreman and owner, a notarized letter cosigned by each attesting to the satisfactory completion of said testing shall be forwarded to the owner and the fire department.

The contractor shall leave the fire alarm system in proper working order, and, without additional expense to the owner, shall replace any defective materials or equipment provided by him under this contract within one year (365 days) from the date of final acceptance by the awarding authority.

Prior to final test the fire department must be notified in accordance with local requirements.

6.3 AS BUILT DRAWINGS, TESTING, AND MAINTENANCE INSTRUCTIONS

6.3.1 AS-BUILT DRAWINGS

A complete set of reproducible "as-built" drawings showing installed wiring, color coding, and wire tag notations for exact locations of all installed equipment, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of system.

6.3.2 OPERATING AND INSTRUCTION MANUALS

Operating and instruction manuals shall be submitted prior to testing of the system. Three (3) complete sets of operating and instruction manuals shall be delivered to the owner upon completion. User operating instructions shall be provided prominently displayed on a separate sheet located next to the control unit in accordance with U.L. Standard 864.

END OF SECTION 28 31 00

SECTION 31 05 13 SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Subsoil materials.
 - 2. Topsoil materials.
- B. Related Sections:
 - 1. Section 310513 - Aggregates for Earthwork.
 - 2. Section 320516 - Aggregates for Exterior Improvements.
 - 3. Section 312213 - Rough Grading.
 - 4. Section 312323 - Backfill.
 - 5. Section 312317 - Trenching.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

PART 2 PRODUCTS

2.1 SOURCE QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Testing and Inspection Services Testing and analysis of soil material.
- B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698.
- C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D698.
- D. When tests indicate materials do not meet specified requirements, change material and retest.
- E. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

- A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.
- B. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.
- C. Remove excess excavated materials subsoil and topsoil not intended for reuse, from site.
- D. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from site.

3.2 STOCKPILING

- A. Stockpile materials on site at locations designated by Architect/Engineer.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 310513

SECTION 31 06 00 - EXCAVATION, BACKFILLING AND COMPACTING FOR STRUCTURE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavate to line, grade and configuration as shown in the plans and specifications for proposed structures and expansion areas.
- B. Fill to line, grade and configuration as shown in the plans and specifications for proposed structures and expansion areas.
- C. Compacting for materials in an acceptable manner as stated herein.

1.2 RELATED SECTIONS

- A. Section 31 14 00 - Earthwork
- B. Section 31 20 00 - Aggregate material
- C. Section 31 32 00 - Soil Stabilization
- D. Section 32 12 00 - Asphaltic Concrete Paving
- E. Section 32 13 00 - Portland Cement Concrete Paving
- G. Geotechnical report (if available) for boring locations and findings of subsurface materials and conditions.
- H. Construction drawings.
- I. Architectural plans and specifications as they relate specifically to earthwork beneath the buildings, where the architectural requirements are more stringent than the civil requirements.

1.3 REFERENCE STANDARDS

- A. American society for testing and materials (ASTM) latest edition.
 - D 422 Method for particle size analysis of soils.
 - D 698 Test for moisture-density relations of soils using 5.5 lb. (2.5 kg) Rammer and 12 inch (304.8 mm) drop (Standard Proctor).
 - D 1556 Test for density of soil in place by the sand cone method.
 - D 1557 Test for moisture-density relations of soils using 10-lb (4.5 kg) Rammer and 18-inch (457 mm) drop (Modified Proctor).
 - D 1559 Test method for resistance to plastic flow of bituminous mixtures using Marshall Apparatus.
 - D 2167 Test for density of soil in place by the Rubber Balloon Method.
 - D 2216 Laboratory determination of moisture content of soil.
 - D 2487 Classification of soils for engineering purposes.
 - D 2922 Tests for density of soil and soil-aggregate in place by nuclear methods (shallow depth).
 - D 3017 Test for moisture content of soil and soil aggregate in place by nuclear methods (shallow depth)
 - D4318 Test for plastic limit, liquid limit, & plasticity index of soils.
 - C25 Chemical analysis of limestone, quicklime and hydrated lime.
 - C110 Physical testing for quicklime and hydrated lime, wet sieve method.
 - C618 Specification for fly ash and raw or calcined natural pozzolan for use as a mineral admixture in Portland cement concrete.
 - C977 Quicklime and hydrated lime for soil stabilization.
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition.
 - T88 Mechanical Analysis of Soils.

1.4 QUALITY ASSURANCE

Independent testing laboratory selected and paid by owner shall be retained to perform construction testing on filling operations and subgrade analysis as specified in Section 31 14 00 and as stated herein.

1.5 SUBMITTALS

- A. Shop drawings or details pertaining to excavating and filling for structures are not required unless otherwise shown on the drawings or specifications or if contrary procedures to the project documents are proposed.

- B. Submit a sample of each type of off-site fill material that is to be used in backfilling in an air-tight, 10 lb. container for the testing laboratory or submit a gradation and certification of the aggregate material that is to be used to the testing laboratory for review.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fill material from on-site as specified in Section 31 14 00 and approved by the owner or owner's representative.
- B. Fill material from off-site as specified in Section 31 14 00 and approved by the owner or owner's representative.
- C. Aggregate material as specified in Section 31 20 00.

PART 3 EXCAVATION

3.1 PREPARATION

- A. Identify all lines, elevations and grades necessary to construct building subgrades as shown in the plans and specifications.
- B. Carefully protect benchmarks, property corners, monuments or other reference points.
- C. Locate and identify all site utilities that have previously been installed and may be in danger of damage by grading operations.
- D. Locate and identify all existing utilities that are to remain and protect them from damage.
- E. Over excavate and properly prepare areas of subgrade that are not capable of supporting the proposed systems. These areas shall be stabilized by using acceptable filter fabrics and/or aggregate materials placed and compacted as specified.

3.2 EXCAVATION

- A. Excavate building areas to line and grade as shown in the plans and specifications being careful not to over excavate beyond the elevations needed for building subgrades.
- B. Engage all suitable material into the project fill areas as specified in Section 31 14 00.
- C. Unsuitable excavated material is to be disposed of in a manner and location that is acceptable to the owner and local governing agencies.
- D. Perform excavation using capable, well maintained equipment and methods acceptable to the owner and the project document requirements.

3.3 FILLING AND SUBGRADE PREPARATION

- A. Building area subgrade pad shall be that portion of site directly beneath and ten feet (10') beyond the building and appurtenances including the limits of any future building expansion areas as shown on the civil site drawings.
- B. The building area subgrade pad shall be prepared in strict accordance with the "foundation subsurface preparation" as shown on the civil-site drawings and/or the architectural-structural drawings whichever is more stringent. Rock larger than six inches (6") shall not be part of building subgrade fill.
- C. Areas exposed by excavation or stripping and on which building subgrade preparations are to be performed shall be scarified to a minimum depth of 8" and compacted to a minimum of 95% of the optimum density, in accordance with ASTM D 698, (or 92% of the optimum density, in accordance with ASTM D1557) at a moisture content of not less than 1% below and not more than 3% above the optimum moisture content. These areas shall then be proofrolled to detect any areas of insufficient compaction. Proofrolling shall be accomplished by making a minimum of two (2) complete passes with a fully-loaded tandem-axle dump truck, or approved equivalent, in each of the two perpendicular directions under the supervision and direction of a field geotechnical engineer. Areas of failure shall be excavated and recompact as stated above.
- D. Fill materials used in preparation-of building subgrade shall be placed in lifts or layers not to exceed 8" loose measure and compacted to a minimum density of 95% of optimum density, in accordance with ASTM D 698 (or 92% of the optimum density, in accordance with ASTM D

1557), at a moisture content of not less than it below and not more than 3% above the optimum moisture content. Unless specifically stated otherwise in the "foundation subsurface preparation" on the Drawings, the following table stipulates maximum allowable values for plasticity index (PI) and liquid limit (LL) of suitable materials to be used as fill in the specified areas:

| | | |
|---------------------------------------|----|----|
| *Building area, below upper four feet | 20 | 50 |
| *Building area, upper four feet | 12 | 40 |

(*References to depth are to proposed subgrade elevations)

3.4 COMPACTION

- A. Maintain optimum moisture content of fill materials to attain required compaction density.
- B. All materials shall be tested in accordance with Section 31 14 00.
- C. An independent testing laboratory selected and paid by the owner, shall be retained to perform testing on site.
- D. Compaction tests will be as specified in Section 31 14 00 together with the following for building subgrade areas including 10'-0" outside exterior building lines:
 - In cut areas, not less than one compaction test for every 2,500 square feet. In fill areas, same rate of testing for each 8" lift (measured loose).
- E. If compaction requirements are not complied with at any time during construction process, remove and recompact deficient areas until proper compaction is obtained at no additional expense to the Owner.

3.5 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks and dump trucks.
- C. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace in a manner that will comply with compaction requirements by use of materials equal to or better than best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.6 FINISH GRADING

- A. Finish grading shall be in accordance with Section 31 14 00 and as more specifically stated herein.
- B. Grading of building areas shall be checked by string line from grade stakes (blue tops) set at not more than 50' centers. Tolerance of 0.10 feet, more or less, will be permitted. Contractor to provide engineering and field staking necessary for verification of lines, grades, and elevations

END OF SECTION # 31 06 00

SECTION 31 10 00 - SITE PREPARATION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Cleaning site of debris, grass, trees and other plant life in preparation for site or building excavation work.
- B. Protection of existing structures, trees or vegetation indicated on the contract documents to remain.
- C. Stripping topsoil from areas that are to be incorporated into the limits of the project and where so indicated on the construction drawings.

1.2 RELATED SECTIONS

- A. Section 02 41 00 - Demolition
- B. Section 31 14 00 - Earthwork
- C. Section 31 35 00 - Slope Protection and Erosion Control
- D. Construction Drawings

1.3 ENVIRONMENTAL REQUIREMENTS

- A. Construct temporary erosion control systems as shown on the plans or as directed by the engineer to protect adjacent properties and water resources from erosion and sedimentation.
- B. In the event that site work on this project will disturb five (5) or more acres, the contractor shall **NOT** begin construction without a "National Pollution Discharge Elimination System" (NPDES) permit governing the discharge of storm water from the construction site for the entire construction period. The permit requires a "Storm Water Pollution Prevention Plan" (SWP) to be in place during construction which includes monitoring of storm water flows during construction.
The contractor shall be totally responsible for conducting the storm water management practices in accordance with the NPDES permit and for any enforcement action taken or imposed by Federal or State agencies, including the cost of fines, construction delays and remedial actions resulting from the contractors failure to comply with all provisions of the NPDES permit.

1.4 JOB CONDITIONS

- A. Conditions existing at time of inspection for bidding purposes will be maintained by owner in so far as practical.
- B. Variations to conditions or discrepancy in actual conditions as they apply to site preparation operations are to be brought to the attention of the owner prior to the commencement of any site work.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.1 PREPARATION

Verify that existing plant life and clearing limits are clearly tagged, identified and marked in such a manner as to insure their safety throughout construction operations.

3.2 PROTECTION

- A. Locate and identify existing utilities that are to remain and protect them from damage.
- B. Protect trees, plant growth and features designated to remain as final landscape.
- C. Conduct operations with minimum interference to public or private accesses and facilities. Maintain access and egress at all times and clean or sweep any roadways daily or as required by the governing authority. At such times as deemed necessary by the owner, dust control shall be provided with sprinkling systems or equipment provided by the contractor.
- D. Protect bench marks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by

- the same.
- E. Provide traffic control as required, in accordance with the U.S. Department of Transportation "Manual of Uniform Traffic Control Devices" and the state highway department requirements.

3.3 CLEARING

- A. Clear areas required for access to site and execution of work.
- B. Unless otherwise indicated on the drawings, remove trees, shrubs, grass, other vegetation, improvements, or obstructions interfering with installation of new construction. Removal includes digging out stumps and roots. Depressions caused by clearing and grubbing operations are to be filled to subgrade elevation to avoid water ponding. Satisfactory fill material shall be placed in horizontal layers not exceeding 8" loose depth, and thoroughly compacted per fill requirements of this section and Section 31 14 00.
- C. Remove grass, trees, plant life, stumps and all other construction debris from the site to a dump site that is suitable for handling such material according to state laws and regulations.

3.4 TOPSOIL EXCAVATION

- A. Strip topsoil from areas that are to be filled, excavated, landscaped or re-graded to such a depth that it prevents intermingling with underlying subsoil or questionable material.
- B. Cut heavy growths of grass from areas before stripping and remove with the rest of the cleared vegetative material.
- C. Topsoil shall consist of organic surficial soil found in depth of not less than 6". Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones and other objects over 2" in diameter, weeds, roots, and other objectionable material.
- D. Stockpile topsoil in storage piles in areas shown or where directed. Construct storage piles to freely drain surface water. Cover storage piles as required to prevent windblown dust. Dispose of unsuitable topsoil as specified for waste material, unless otherwise specified by owner. Excess topsoil shall be removed from the site by the Contractor unless specifically noted otherwise on the Drawings.

END OF SECTION # 31 10 00

SECTION 31 14 00 – EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Protection, modification and/or installation of utilities as sitework progresses paying particular attention to grade changes and any necessary staging of work.
- B. Cutting, filling and grading to required lines, dimensions, contours and proposed elevations for proposed improvements.
- C. Scarifying, compaction, drying and removal of unsuitable material to ensure proper preparation of areas for fills or proposed improvements.

1.2 RELATED SECTIONS

- A. Section 02 41 00 - Demolition
- B. Section 31 10 00 - Site Preparation
- C. Section 31 23 00 - Excavation, Backfill and Compaction for Utilities
- D. Section 31 22 00 - Excavation, Backfill and Compaction for Pavement
- E. Section 31 20 00 - Aggregate Materials
- F. Section 31 32 00 - Soil Stabilization
- G. Geotechnical Report (if available) for boring locations and findings of subsurface materials and conditions.
- H. Construction Drawings
- I. Architectural Plans and Specifications as they relate specifically to the earthwork beneath the buildings, where the architectural requirements are more stringent than the civil requirements

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.
 - D 422 Method for Particle Size Analysis of Soils
 - D 698 Test for Moisture-Density Relations of Soils Using 5.5 lb. (2.5 kg) Rammer and 12-inch (304.8 mm) Drop (Standard Proctor)
 - D 1556 Test for Density of soil in Place by the Sand Cone method
 - D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Rammer and 18-inch (457 mm) Drop (Modified Proctor)
 - D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - D 2167 Test for Density of Soil in Place by the Rubber Balloon Method
 - D 2216 Laboratory Determination of Moisture content of Soil
 - D 2487 Classification of Soils for Engineering Purposes
 - D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
 - D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
 - C 25 Chemical Analysis of Limestone, Quicklime and Hydrate Lime
 - C110 Physical Testing for Quicklime and Hydrated Lime, Wet Sieve Method
 - C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
 - C977 Quicklime and Hydrated Lime for Soil Stabilization
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - T88 Mechanical Analysis of Soils

1.4 QUALITY ASSURANCE

- A. Independent Testing Laboratory selected and paid by owner, shall be retained to perform construction testing on site based on the following:
 - 1. Building Subgrade Areas, including 10' –0" Outside Exterior Building Lines: In cut areas, not less than one compaction test for every 2,500 square feet. In fill areas, same rate of testing for each 8" lift (measured loose).
 - 2. Areas of Construction exclusive of building subgrade: In cut areas, not less than one compaction test for every 10,000 square feet. In fill areas, same rate of testing for each 8" lift (measured loose).
- B. If compaction requirements are not complied with at any time during construction process, remove and recompact deficient areas until proper compaction is obtained at no additional expense to owner.

- C. In all areas to receive pavement, a CBR (or LBR) test shall be performed for each type of material imported from off-site.
- D. The following tests shall be performed on each type of on-site or imported soil material used as compacted fill as part of construction testing requirements.
 - 1. Moisture and Density Relationship: ASTM D 698 or ASTM D1557.
 - 2. Mechanical Analysis: AASHTO T-88
 - 3. Plasticity Index: ASTM D 4318
- E. Field density tests for in-place materials shall be performed according to one of the following standards as part of construction testing requirements.
 - 1. Sand-Cone Method: ASTM D 1556
 - 2. Balloon Method: ASTM D 2167
 - 3. Nuclear method: ASTM D 2922 (Method B-Direct Transmission)
- F. Independent Testing Laboratory shall prepare test reports that indicate test location, elevation data, and test results. Owner, architect, and contractor shall be provided with copies of reports within 96 hours of time test was performed. In event that any test performed fails to meet these Specifications, owner and contractor shall be notified immediately by independent testing laboratory.
- G. All costs related to retesting due to failures shall be paid for by the contractor at no additional expense to owner. Owner reserves the right to employ an Independent Testing Laboratory and to direct any testing that is deemed necessary. Contractor shall provide free access to site for testing activities.

1.5 SUBMITTALS

- A. Submit a sample of each type of off-site fill materials that is to be used at the site in an air tight, 10 lb container for the testing laboratory.
- B. Submit the name of each material supplier and specific type and source of each material. Any change in source throughout the job requires approval of the owner or engineer.
- C. For use of fabrics or geogrids, a design shall be submitted for approval by the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Excavated and re-used material for subsoil fill as specified herein.
- B. Aggregate fill as specified in Section 31 20 00.
- C. Imported subsoil material approved by the owner and specified herein.
- D. Topsoil fill as specified in Section 31 10 00.
- E. Acceptable stabilization fabrics and Geogrids:
 - 1. Mirafi 500X or 600X
 - 2. Phillips 66 Supac 6WS
 - 3. Dupont Typar 3401 and 3601
 - 4. Trevira S1114 and S1120
 - 5. Tensar SS-1 and SS-2
 - 6. Exxon GTF-200 or 350
- F. Filter/Drainage Fabrics
 - 1. Mirafi 14ONS
 - 2. Phillips 66 Supac 4NP
 - 3. Dupont Typar 3341

PART 3 EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours and datum.
- B. Locate and identify existing utilities that are to remain and protect them from damage.
- C. Notify utility companies to remove and/or relocate any utilities that are in conflict with the proposed improvements.
- D. Protect plant life, lawns, fences, existing structures, sidewalks, paving and curbs from excavating equipment and vehicular traffic.

- E. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same.
- F. Remove from site material encountered in grading operations that, in opinion of owner or owners representative, is unsuitable or undesirable for backfilling, subgrade or foundation purposes. Dispose of in a manner satisfactory to owner. Backfill areas with layers of suitable material and compact as specified.
- G. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform following procedures:
 - 1. Drain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain same results.
 - 2. After drainage of low area is complete, remove mulch, mud, debris, and other unsuitable material by using acceptable equipment and methods that will keep natural soils underlying low areas dry and undisturbed.
 - 3. If proposed for fill, all muck, mud, and other materials removed from above low areas shall be dried on-site by spreading in thin layers for observation by owner or owner's representative. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under the building area or within all of perimeter of building pad or paving subgrade. If, after observation by owner or owners representative, material is found to be unsuitable, all unsuitable material shall be removed from site.

3.2 EXCAVATION FOR FILLING AND GRADING

- A. Classification of Excavation: Contractor by submitting bid acknowledges that he has investigated the site to determine type, quantity, quality, and character of excavation work to be performed. Excavation shall be considered unclassified excavation, except as indicated by "Article 4 - Administration of the Contract" in the "Supplementary Conditions" portion of the specification.
- B. Perform excavation using capable, well maintained equipment and methods acceptable to owner and governing agencies.
- C. When performing grading operations during periods of wet weather, provide adequate drainage and ground water management to control moisture of soils.
- D. Shore, brace, and drain excavations as necessary to maintain safe, secure, and free of water at all times.
- E. Excavated material containing rock or stone greater than 6" in largest dimension is unacceptable as fill to within the proposed building and paving area.
- F. Rock or stone less than 6" in largest dimension is acceptable as fill to within 24" of surface of proposed subgrade when mixed with suitable material.
- G. Rock or stone less than 2" in largest dimension and mixed with suitable material is acceptable as fill within the upper 24" of proposed subgrade.

3.3 FILLING AND SUBGRADE PREPARATION

- A. Fill areas to contours and elevations shown with unfrozen materials.
- B. Place fill in continuous lifts specified herein.
- C. Refer to Section 31 22 00 for filling requirements for pavements.
- D. Areas exposed by excavation or stripping and on which subgrade preparations are to be performed shall be scarified to minimum depth of 8" and compacted to minimum of 95% of optimum density, in accordance with ASTM D 698 (or 92% of optimum density, in accordance with ASTM D 1557), at a moisture content of not less than 1% below and not more than 3% above the optimum moisture content. These areas shall then be proofrolled to detect any areas of insufficient compaction. Proofrolling shall be accomplished by making a minimum of two (2) complete passes with a fully-loaded tandem-axle dump truck, or approved equivalent, in each of the two perpendicular directions under the supervision and direction of a field geotechnical engineer. Areas of failure shall be excavated and recompacted as stated above.
- E. Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 8" loose measure and compacted to a minimum density of 95% of optimum density, in accordance with ASTM D 698, (or 92% of the optimum density, in accordance with ASTM D 1557) at a moisture content of not less than it below and not more than 3% above the optimum moisture content.
- F. Material imported from off -site shall have a CBR (California Bearing Ratio) or LBR (Limerock Bearing Ratio) value equal to or above the pavement design subgrade CBR or LBR value indicated on the Drawings.

3.4 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks and dump trucks.
- B. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in a manner that will comply with compaction requirements by use of material equal to or better than best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.5 RIP RAP

- A. Place rip-rap in all areas where indicated on the Drawings. The stone for rip-rap shall consist of field stone or rough unhewn quarry stone as nearly uniform, in section as is practical. The stones shall be dense, resistant to the action of air and water, and suitable in all aspects for the purpose intended. Unless otherwise specified, all stones used as rip-rap shall weigh between 50 and 150 pounds each, and at least 60 percent of the stones shall weigh more than 100 pounds each.
- B. Slopes and other areas to be protected shall be dressed to the line and grade shown on the plans prior to the placing of rip-rap. Contractor shall undercut the areas to receive rip-rap to an elevation equal to the final elevation less the average diameter of the stones before placing the rip-rap.
- C. Filter fabric and bedding stone shall be installed prior to the placement of the stones if so indicated on the drawings. The bedding stone shall be quarried and crushed angular limestone in accordance with Section 31 20 00 and shall be 6" in depth. Filter fabric shall be as specified herein and as detailed on the plans.
- D. Stones shall be placed so that the greater portion of their weight is carried by the earth and not by the adjacent stones. The stones shall be placed in a single layer with close joints. The upright areas of the stone shall make an angle of approximately 90 degree with the embankment slope. The courses shall be placed from the bottom of the embankment upward, the larger stones being placed in the lower courses. Open joints shall be filled with spalls. Stones shall be embedded in the embankment as necessary to present a uniform top surface such that the variation between tops of adjacent stones shall not exceed three inches.

3.6 FINISH GRADING

- A. Grade all areas where finish grade elevations or contours are indicated on Drawings, other than paved areas and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Finished subgrade surface shall not be more than 0.10 feet above or below established finished subgrade elevation, and all ground surfaces shall vary uniformly between indicated elevations. Finish ditches shall be graded to allow for proper drainage without ponding and in a manner that will minimize erosion potential.
- B. Correct all settlement and eroded areas within one year after date of completion at no additional expense to owner. Bring grades to proper elevation. Replant or replace any grass, shrubs, bushes, or other vegetation that appears dead, dying or disturbed by construction activities. Refer to Section 31 35 00 for slope protection and erosion control.
- C. Refer to Section 31 32 00 for soil stabilization using lime, cement, fly ash and geotextile fabric methods for subbase materials.

END OF SECTION # 31 14 00

SECTION 31 20 00 - AGGREGATE MATERIALS

PART 1 GENERAL

1.1 SECTION INCLUDES

Aggregate Materials

1.2 RELATED SECTIONS

- A. Section 31 10 00 - Site Preparation
- B. Section 31 14 00 - Earthwork
- C. Section 31 06 00 - Excavation, Backfill and Compaction for Structures
- D. Section 31 23 00 - Excavation, Backfill and Compaction for Utilities
- E. Section 31 22 00 - Excavation, Backfill and Compaction for Pavement
- F. Section 31 32 00 - Soil Stabilization
- G. Section 31 35 00 - Slope Protection and Erosion Control
- H. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.
 - ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
 - ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
 - ANSI/ASTM D155 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
 - ASTM D2167 - Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - ASTM D2487 - Classification of Soils for Engineering Purposes.
 - ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
 - ASTM D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition.
 - AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 Kg) Rammer and an 18 inch (457 mm) Drop.
 - AASHTO M147 - Materials for Aggregate and Soil-Aggregate.

1.4 QUALITY ASSURANCE

Tests and analysis of aggregate material will be performed in accordance with standard ASTM and AASHTO procedures listed herein.

1.5 SUBMITTALS

- A. Submit in air tight containers a 10 pound sample of each aggregate or mixture that is to be incorporated into the project to the testing laboratory designated by the owner.
- B. Submit the name of each material supplier and specific type and source of each material. Any change in source throughout the job requires approval of the owner and engineer.
- C. Submit materials certificate to on-site independent testing laboratory which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All construction and materials shall meet or exceed the requirements of this section and any state highway department specification section referred to or noted on the drawings which pertain to

AGGREGATE MATERIALS
SECTION # 31 20 00-1

paving base course design, materials, preparation, and/or execution. All materials shall be as indicated on Drawings and shall comply with applicable state highway specification regarding source, quality, gradation, liquid limit, plasticity index, and mix proportioning.

PART 3 EXECUTION

3.1 STOCKPILING

Stockpile on-site at locations indicated by the owner in such a manner that there will be no standing water or mixing with other materials.

3.2 BORROW SITES

Upon completion of borrow operations, clean up borrow areas as indicated on the plans in a neat and reasonable manner to the satisfaction of the property owner, the owner and the engineer.

3.3 TRANSPORTATION

Off-site materials shall be transported to the project using well maintained and operating vehicles. Once on the job site, all transporting vehicles shall stay on designated haul roads and shall at no time endanger any of the improvements by rutting, overloading or pumping the haul road.

END OF SECTION # 31 20 00

SECTION 31 22 00 - EXCAVATION, BACKFILLING AND COMPACTING FOR PAVEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavate to line, grade and configuration as shown in the plans and specifications for proposed and future pavement areas.
- B. Fill to line, grade and configuration as shown in the plans and specifications for proposed and future pavement areas.
- C. Compacting fill materials in an acceptable manner as stated herein.

1.2 RELATED SECTIONS

- A. Section 31 14 00 - Earthwork
- B. Section 31 20 00- Aggregate Materials
- C. Section 31 32 00 - Soil Stabilization
- D. Section 32 11 00- Paving Base Course
- E. Section 32 12 00 - Asphaltic Concrete Paving
- F. Section 32 13 00 - Portland Cement Concrete
- G. Section 32 16 00 - Curbs and Sidewalks
- H. Geotechnical Report (if available) for Boring Locations and Findings of Subsurface Materials and Conditions.
- I. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.
 - D 422 Method for Particle Size Analysis of Soils
 - D 698 Test for Moisture-Density Relations of Soils Using 5.5 lb. (2.5 kg) Rammer and 12-inch (304.8 mm) Drop (Standard Proctor)
 - D 1556 Test for Density of soil in Place by the Sand Cone Method
 - D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Rammer and 18-inch (457 mm) Drop (Modified Proctor)
 - D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - D 2167 Test for Density of Soil in Place by the Rubber Balloon Method
 - D 2216 Laboratory Determination of Moisture content of Soil
 - D 2487 Classification of Soils for Engineering Purposes
 - D 2922 Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
 - C 25 Chemical Analysis of Limestone, Quicklime and Hydrated Lime
 - C110 Physical Testing for Quicklime and Hydrated Lime, Wet Sieve Method
 - C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
 - C977 Quicklime and Hydrated Lime for Soil Stabilization
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - T88 Mechanical Analysis of Soils

1.4 QUALITY ASSURANCE

Independent testing laboratory selected and paid by owner shall be retained to perform construction testing on filling operations and subgrade analysis as specified in Section 31 14 00 and as stated herein.

1.5 SUBMITTALS

- A. Shop drawings or details pertaining to excavating and filling for pavement are not required unless otherwise shown on the drawings or specifications or if contrary procedures to the project documents are proposed.

EXCAVATION, BACKFILLING AND COMPACTING FOR PAVEMENT
SECTION # 31 22 00 - 1

- B. Submit a sample of each type of off-site fill material that is to be used in backfilling in an air-tight, 10 lb. container for the testing laboratory or submit a gradation and certification of the aggregate material that is to be used to the testing laboratory for review.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fill material from on-site as specified in Section 31 14 00 and approved by the owner or owner's representative.
- B. Fill material from off-site as specified in Section 31 14 00 and approved by the owner or owner's representative.
- C. Aggregate material as specified in Section 31 20 00.
- D. Acceptable stabilization fabrics and geogrids:
 - 1. Mirafi 500X or 600X
 - 2. Phillips 66 Supac 6WS
 - 3. Dupont Typar 3401 and 3601
 - 4. Trevira S1114 and S1120
 - 5. Tensar SS-1 and SS-2
 - 6. Exxon GTF-200 or 350

PART 3 EXECUTION

3.1 PREPARATION

- A. Identify all lines, elevations and grades necessary to construct pavements, curb and gutter, bases, walkways and roadways as shown in the plans and specifications.
- B. Carefully protect benchmarks, property corners, monuments or other reference points.
- C. Locate and identify all site utilities that have previously been installed and may be in danger of damage by grading operations.
- D. Locate and identify all existing utilities that are to remain and protect them from damage.
- E. Over excavate and properly prepare areas of subgrade that are not capable of supporting the proposed systems. These areas shall be stabilized by using acceptable filter fabrics and/or aggregate material placed and compacted as specified.

3.2 EXCAVATION

- A. Excavate roadway and pavement areas to line and grade as shown in the plans and specifications.
- B. Engage all suitable material into the project fill areas as specified in Section 31 14 00
- C. Unsuitable excavated material is to be disposed of in a manner and location that is acceptable to the owner and local governing agencies.
- D. Perform excavation using capable, well maintained equipment and methods acceptable to the owner and the project document requirements.

3.3 FILLING AND SUBGRADE PREPARATION

- A. Areas exposed by excavation or stripping and on which subgrade preparations for paving are to be performed, including future pavement areas, shall be scarified to minimum depth of 8", and compacted to minimum of 95% of optimum density, in accordance with ASTM D 698 (or 92% of optimum density, in accordance with ASTM D 1557), at a moisture content of not less than 1% below and not more than 3% above the optimum moisture content. These areas shall then be proofrolled to detect any areas of insufficient compaction. Proofrolling shall be accomplished by making a minimum of two (2) complete passes with a fully-loaded tandem-axle dump truck, or approved equivalent, in each of the two perpendicular directions under the supervision and direction of a field geotechnical engineer. Areas of failure shall be excavated and recompacted as stated above.
- B. Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 8" loose measure and compacted to a minimum density of 95% of optimum density, in accordance with ASTM D 698, (or 92% of the optimum density, in accordance with ASTM D 1557) at a moisture content of not less than it below and not more than 3% above the optimum moisture content.

- C. The following table stipulates maximum allowable values for plasticity index (PI) and liquid limit (LL) of suitable fill materials to be used in the specified areas, unless specifically stated otherwise on the Drawings:

| | <u>PI</u> | <u>LL</u> |
|------------------------------------|-----------|-----------|
| *Paving Area, below upper two feet | 20 | 50 |
| *Paving Area, upper two feet | 15 | 40 |

(*References to Depth are to Proposed Subgrade Elevations)

- D. Material imported from off-site shall have a CBR (California Bearing Ratio) or LBR (Limerock Bearing Ratio) value equal to or above the pavement design subgrade CBR or LBR value indicated on the Drawings.

3.4 COMPACTION

- A. Maintain optimum moisture content of fill materials to attain required compaction density.
- B. All materials shall be tested in accordance with Section 31 14 00
- C. An independent testing laboratory selected and paid by the owner, shall be retained to perform testing on-site.
- D. Compaction test will be as specified in Section 31 14 00 together with the following for paving areas:
 - 1. In cut areas not less than one compaction test for every 10,000 square feet.
 - 2. In fill areas, same rate of testing for each 8" lift (measured loose).
- E. If compaction requirements are not complied with at any time during construction process, remove and recompact deficient areas until proper compaction is obtained at no additional expense to owner.

3.5 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction including concrete trucks and dump trucks.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in a manner that will comply with compaction requirements by use of material equal to or better than best subgrade material on-site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.6 FINISH GRADING

- A. Finish grading shall be in accordance with Section 31 14 00 and as more specifically stated herein.
- B. Grading of paving areas shall be checked by string line from grade stakes (blue tops) set at not more than 501 centers. Tolerances of .10 feet, more or less, will be permitted. Contractor to provide engineering and field staking necessary for verification of lines, grades, and elevations.

END OF SECTION # 31 22 00

SECTION 312213 ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Excavating topsoil.
 - 2. Excavating subsoil.
 - 3. Cutting, grading, filling, compacting site for site structures, building pads.
- B. Related Sections:
 - 1. Section 310513 - Soils for Earthwork: Soils for fill.
 - 2. Section 310516 - Aggregates for Earthwork: Aggregates for fill.
 - 3. Section 311000 - Site Clearing: Excavating topsoil.
 - 4. Section 312316 - Excavation and Fill: Building excavation.
 - 5. Section 312318 - Rock Removal.
 - 6. Section 312323 - Backfill: General building area backfilling.
 - 7. Section 312317 - Trenching: Trenching and backfilling for utilities.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 3. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - 7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
 - 8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

PART 2 EXECUTION

2.1 PREPARATION

- A. Call Local Utility Line Information service not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum.
- C. Protect utilities indicated to remain from damage.
- D. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

2.2 FILLING

- A. Fill areas to contours and elevations with unfrozen materials.
- B. Place fill material in continuous layers and compact as required.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.
- D. Slope grade away from building minimum 2 percent slope for minimum distance of 10 ft, unless noted otherwise.
- E. Make grade changes gradual. Blend slope into level areas.

2.3 FIELD QUALITY CONTROL

- A. Perform in place compaction tests in accordance with the following:
 - 1. As required by geotechnical engineer.

END OF SECTION 312213

SECTION 31 23 00 - EXCAVATION, BACKFILLING AND COMPACTING FOR UTILITIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Excavating trenches for the installation of utilities
- B. Backfilling trench with bedding material as specified and indicated and finishing filling trench with suitable material to proposed subgrade.
- C. Compacting backfill materials in an acceptable manner
- D. Borings and casings under roads

1.2 RELATED SECTIONS

- A. Section 31 14 00 - Earthwork
- B. Section 31 20 00 - Aggregate Materials
- C. Section 33 39 00 - Sewer Structures
- D. Section 33 11 00 - Water Distribution Systems
- E. Section 33 41 00 - Storm Sewer Systems
- F. Section 33 31 00 - Sanitary Sewer Systems
- G. Geotechnical report (if available) for boring locations and findings of subsurface materials and conditions
- H. Construction Drawings

1.3 REFERENCE STANDARDS

- A. American society for testing and materials (ASTM) Latest Edition
 - D 422 Method for Particle Size Analysis
 - D 698 Test for Moisture-Density Relations of Soils Using 5.5-lb. (2.5 Kg) Rammer and 12-inch (304.8mm) Drop (Standard Proctor)
 - D 1556 Test for Density of Soil in Place by the Sand Cone Method
 - D 1557 Test for Moisture-Density Relations of Soils Using 10-lb. (4.5 Kg) Rammer and 18-inch (457 mm) Drop (Modified Proctor)
 - D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - D 2216 Laboratory Determination of Moisture Content of Soil
 - D 2487 Classification of Soils for Engineering Purposes
 - D 2922 Tests for Density of Soil and Soil-Aggregate in Place by Nuclear methods (Shallow Depth)
 - D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - D 4318 Test for Plastic Limit, Liquid Limit, & Plasticity Index of Soils
 - C 25 Chemical Analysis of Limestone, Quicklime and Hydrated Lime.
 - C 110 Physical Testing for Quicklime and Hydrated Lime, Wet Sieve Method
 - C 618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
 - C 977 Quicklime and Hydrated Lime for Soil Stabilization
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
 - T88 Mechanical Analysis of Soils

1.4 QUALITY ASSURANCE

Independent testing laboratory selected and paid by owner, shall be retained to perform construction testing on backfilling operations as specified in Section 31 14 00 and as stated herein.

1.5 SUBMITTALS

- A. Shop Drawings or details pertaining to Site Utilities are not required unless required by regulatory authorities or unless use of materials, methods, equipment, or procedures are contrary to Drawings or these

EXCAVATION, BACKFILLING AND COMPACTING FOR UTILITIES
SECTION # 31 23 00-1

specifications are proposed. Do not perform work until required shop drawings have been accepted by Owner.

- B. The Contractor shall contact all utility companies and determine if additional easements will be required to complete the project. Contractor shall provide written confirmation of the status of all easements to the Owner's Construction Manager at the time of the preconstruction conference or no later than 90 days prior to the project possession date.
- C. Submit a sample of each type of offsite fill material that is to be used in backfilling in an air-tight, 10 lb container for the testing laboratory or submit a gradation and certification of the aggregate material that is to be used to the testing laboratory for review.

1.6 PROJECT RECORD DOCUMENTS

Accurately record actual locations of all subsurface utilities, structures and obstructions encountered.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Bedding Material: Processed sand and gravel free from clay lumps, organic, or other deleterious material, and complying with following gradation requirements:

| <u>U. S. Sieve Size</u> | <u>Percent Passing (by weight)</u> |
|-------------------------|------------------------------------|
| 1 Inch | 100 |
| 3/4 Inch | 90-100 |
| 3/8 Inch | 20- 55 |
| No. 4 | 0- 10 |
| No. 8 | 0- 5 |

- B. Backfill material from site as specified in Section 31 14 00 and approved by the owner or owner's representative.
- C. Backfill material from offsite as specified in Section 31 14 00 and approved by the owner or owner's representative.
- D. Steel Casing Pipe: Comply with AWWA C-201 or C-202, minimum grade B, size and wall thickness as indicated on Drawings.
- E. Acceptable Stabilization Fabrics and Geogrids
 1. Mirafi 500X or 600X
 2. Phillips 66 Supac 6WS
 3. Dupont Tytar 3401 and 3601
 4. Trevira S1114 and S1120
 5. Tensar SS-1 and SS-2
 6. Exxon GTF-200 or 350
- F. Filter/Drainage Fabrics
 1. Mirafi 140 NS
 2. Phillips 66 Supac 4NP
 3. Dupont Tytar 3341

PART 3 EXECUTION

3.1 PREPARATION

- A. Set all lines, elevations, and grades for utility and drainage system work and control system for duration of work, including careful maintenance of bench marks, property corners, monuments, or other reference points.
- B. Maintain in operating condition all existing utilities, active utilities and drainage systems encountered in utility installation. Repair any surface or subsurface improvements shown on Drawings.
- C. Verify location, size, elevation, and other pertinent data required to make connections to existing utilities and drainage systems as indicated on Drawings. Contractor shall comply with local codes and regulations.
- D. Over excavate and properly prepare areas of subgrade that are not capable of supporting the proposed systems. These areas shall be stabilized by using acceptable filter fabrics and/or additional bedding material placed and compacted as specified.

- E. Install dewatering systems that will be required to construct the proposed utilities in a manner that is described herein.

3.2 EXCAVATION

- A. The local utility companies shall be contacted before excavation shall begin. Dig trench at proper width and depth for laying pipe, conduit, or cable. Cut trench banks vertical if possible and remove stones from bottom of trench as necessary to avoid point-bearing. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide suitable base for continuous and uniform bedding.
- B. All trench excavation side walls greater than 5 feet in depth shall be sloped, shored, sheeted, braced or otherwise supported by means of sufficient strength to protect the workmen within them in accordance with the applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to an exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.
- C. Perform excavation as indicated for specified depths. During excavation, stockpile materials suitable for backfilling in orderly manner far enough from bank of trench to avoid overloading, slides, or cave-ins.
- D. Remove excavated materials not required or not suitable for backfill or embankments and waste as specified. Any structures discovered during excavation(s) shall be disposed of as specified.
- E. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches or other excavations by pumping or other acceptable methods.
- F. Open cut excavation with trenching machine or backhoe. Where machines other than ladder or wheel-type trenching machines are used, do not use clods for backfill. Dispose of unsuitable material and provide other suitable material at no additional cost to Owner.
- G. Accurately grade trench bottom to provide uniform bearing and support for each section of pipe on bedding material at every point along entire length, except where necessary to excavate for bell holes, proper sealing of pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make joint connection properly.
- H. Trench width requirements below the top of the pipe shall not be less than 12" nor more than 18", wider than outside surface of any pipe or conduit that is to be installed to designated elevations and grades. All other trench width requirements for pipe, conduit, or cable shall be the least practical width that will allow for proper compaction of trench backfill.
- I. Trench depth requirements measured from finished grade or paved surface shall meet the following requirements or applicable codes and ordinances:
 - 1. Water Mains: 30" to top of pipe barrel or 6", below the frost line (established by the local building official), whichever is deeper.
 - 2. Sanitary Sewer: Elevations, and grades as indicated on Drawings.
 - 3. Storm Sewer: Depths, elevations, and grades as shown on Drawings.
 - 4. Electrical Conduits: 24" minimum to top of conduit or as required by NEC 300-5, NEC 710-36 codes, or the local utility company requirements, whichever is deeper.
 - 5. TV Conduits: 18" minimum to top of conduit or as required by the local utility company, whichever is deeper.
 - 6. Telephone Conduits: 18" minimum to top of conduit, or as required by the local utility company, whichever is deeper.
 - 7. Gas Mains and Service: 30" minimum to top of pipe, or as required by the local utility company, whichever is deeper.
- J. Provide sheeting and bracing, when necessary, in trenches and other excavations where protection of workmen required. Sheeting may be removed after sufficient backfilling to protect against damaging or injurious caving.

3.3 PIPE BEDDING

- A. Accurately cut trenches for pipe or conduit that is installed to designated elevations 4" below bottom of pipe and to width as specified. Place 40 of bedding material, compact in bottom of trench, and accurately shape to conform to lower portion of pipe barrel. After pipe installation, place backfill as specified and compact in maximum 8" layers measured loose to the top of the trench.
- B. Place geotextile fabric as specified on the plans and specifications.

3.4 BACKFILLING

EXCAVATION, BACKFILLING AND COMPACTING FOR UTILITIES
SECTION # 31 23 00-3

- A. Criteria: Trenches shall not be backfilled until required tests are performed and the utility systems comply with and are accepted by applicable governing authorities. Backfill trenches as specified. If improperly backfilled, reopen to depth required to obtain proper compaction. Backfill and compact, as specified, to properly correct condition in an acceptable manner.
- B. Backfilling: After pipe or conduit has been installed, bedded, and tested as specified, backfill trench or structure excavation with specified material placed in 8" maximum loose lifts.
- C. Backfill trenches to the contours and elevations shown on the plans with unfrozen materials.
- D. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

3.5 COMPACTION

- A. Exercise proper caution when compacting immediately over top of pipes or conduits. water jetting or flooding is not permitted as a method of compaction.
- B. Maintain optimum moisture content of fill materials to attain required compaction density.
- C. An independent testing laboratory shall perform testing at intervals not exceeding 200' of trench for the first and every other eight-inch (8") lift of compacted trench backfill and furnish copies of test results as specified. Compact to minimum density of 95% of optimum density in accordance with ASTM D 699 or 92% of optimum density in accordance with ASTM D1557.
- D. All materials used for backfill shall comply with the requirements of Section 31 14 00.

3.6 BORINGS AND CASINGS UNDER ROADS, HIGHWAYS AND RAILROAD CROSSINGS

- A. When indicated by Drawings and specifications, all street, road, highway, or railroad crossings for utility mains installed by the jacking and boring method shall be in accordance with area specifications and governing authorities.
- B. Excavation of approach pits and trenches within right- of-way of street, road, highway, or railroad shall be of sufficient distance from paving or railroad tracks to permit traffic to pass without interference. Tamp backfill for approach pits and trenches within right - of -way in layers not greater than 6", thick for entire length and depth of trench or pit. Compact backfill to 95% of maximum density obtained at optimum moisture as determined by AASHTO T 180-57, Method A. Mechanical tampers may be used after cover of 6" has been obtained over top of barrel of pipe.
- C. Accomplish boring operation using commercial type boring rig and hole shall be bored to proper alignment and grade and within 2" of same diameter as largest outside joint diameter of pipe installed. Install pipe in hole immediately after bore has been made, and in no instance shall hole be left open while unattended.
- D. In event subsurface operations result in failure or damage to pavement within one year of construction, Contractor shall make necessary repairs to pavement at no additional cost to Owner. In event paving cracks on either side of pipe line or is otherwise disturbed or broken due to construction operations, Contractor shall repair or replace disturbed or broken area at no additional expense to the Owner.
- E. Clean and prime interior and exterior of casing pipe; and line with two coats of asphalt in accordance with area specifications and governing authorities.
- F. Butt weld steel casing welds shall be full penetration single butt-welds in accordance with AWWA C-205 and AWS D7-0-62.
- G. Install casing and utility pipe with end seals, vent pipe, and other special equipment in accordance with area specifications and governing authorities.

END OF SECTION # 31 23 00

SECTION 312316 EXCAVATION AND FILL

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Soil densification.
 - 2. Excavating for building foundations.
 - 3. Excavating for slabs-on-grade.
 - 4. Excavating for site structures.
- B. Related Sections:
 - 1. Section 310513 - Soils for Earthwork: Stockpiling excavated materials.
 - 2. Section 310516 - Aggregates for Earthwork: Stockpiling excavated materials.
 - 3. Section 312213 - Rough Grading: Topsoil and subsoil removal from site surface.
 - 4. Section 312318- Rock Removal: Removal of rock during excavating.
 - 5. Section 312323- Backfill.
 - 6. Section 312317 - Trenching: Excavating for utility trenches.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 2. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
 - 3. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- B. Local utility standards when working within 24 inches of utility lines.

PART 2 EXECUTION

2.1 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work.
- B. Excavate subsoil to accommodate building foundations, slabs-on-grade.
- C. Excavate to working elevation for piling work.
- D. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 02320 and Section 02324.
- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Trim excavation. Remove loose matter.

- G. Notify Architect/Engineer of unexpected subsurface conditions.
- H. Correct areas over excavated with structural fill.
- I. Remove excess and unsuitable material from site.
- J. Repair or replace items indicated to remain damaged by excavation.

2.2 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION 312316

SECTION 313116 TERMITE CONTROL

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Soil treatment for termite control.
- B. Related Sections:
 - 1. Section 310513 - Soils for Earthwork: Backfill materials.
 - 2. Section 312316 - Excavation and Fill: Subgrade preparation.
 - 3. Section 033000 - Cast-In-Place Concrete: Slabs on grade and foundations placed over treated soil.

1.2 REFERENCES

- A. Environmental Protection Agency:
 - 1. EPA FIFRA - Federal Insecticide, Fungicide and Rodenticide Act.
- B. National Pest Management Association:
 - 1. NPMA WDO - Wood Destroying Organism Library.

1.3 SUBMITTALS

- A. Product Data: Submit toxicants to be used, composition by percentage, dilution schedule, intended application rate. Include product label information.
- B. Test Reports: Indicate regulatory agency approval reports.
- C. Manufacturer's Application Instructions: Indicate caution requirements and in accordance with current product label of chosen pesticide.
- D. Certify applications followed NPMA WDO for termite control or other regional location guidance.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record moisture content of soil before application, date and rate of application, areas of application, diary of toxicity meter readings and corresponding soil coverage.
- B. Operation and Maintenance Data: Indicate re-treatment schedule.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

- B. Applicator: Company specializing in performing the Work of this section and licensed in State of Texas.

1.6 SEQUENCING

- A. Section 011000 - Summary: Work sequence.
- B. Apply toxicant immediately prior to installation of vapor barrier under slabs-on-grade in accordance with product label supplemented by the NPCA's ARP for termiticiding or local requirements.

1.7 WARRANTY

- A. Warranty: Include coverage for damage and repairs to building and building contents caused by termites. Repair damage. Re-treat where required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Toxicant Chemical: EPA FIFRA approved; synthetically color dyed to permit visual identification of treated soil.
- B. Diluent: Recommended by toxicant manufacturer.

2.2 MIXES

- A. Mix toxicant to manufacturer's instructions.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
- C. Verify final grading and excavation are complete.

3.2 APPLICATION

- A. Apply toxicant at locations indicated in Schedule at end of section.
- B. Apply extra treatment to structure penetration surfaces including pipe or ducts, and soil penetrations including grounding rods or posts.

- C. Re-treat disturbed treated soil with same toxicant as original treatment.
- D. When inspection or testing identifies presence of termites, re-treat soil and re-test.

3.3 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution Requirements: Protecting finished Work.
- B. Do not permit soil grading over treated work.

3.4 SCHEDULES

- A. Locations:
 - 1. Under Slabs-on-Grade.
 - 2. Both Sides of Foundation Surface.

END OF SECTION 313116

SECTION 31 32 00 - SOIL STABILIZATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Lime Stabilized Subgrade
- B. Cement Stabilized Subgrade
- C. Fly Ash Stabilized Subgrade
- D. Geotextile Fabric Stabilized Subgrade

1.2 RELATED SECTIONS

- A. Section 31 14 00 - Earthwork
- B. Section 31 22 00 - Excavation, Backfill and Compacting for Pavement
- C. Section 31 20 00 - Aggregate Materials
- D. Construction Drawings
- E. Geotechnical Report (if available) for boring locations and findings of subsurface materials and conditions.

1.3 REFERENCE STANDARDS

- A. American Society for Testing Materials (ASTM) latest edition.
 - C 150- Portland Cement
 - C 618- Fly Ash for Soil Stabilization
 - C 977- Quicklime and Hydrated Lime for Soil Stabilization
 - D 1633- Test method for compressive strength of molded soil cement cylinders
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition.
 - M 216 - Lime for Soil Stabilization
- C. National Lime Association (NLA)
 - Bulletin 326 - Lime Stabilization Construction Manual

1.4 ENVIRONMENTAL REQUIREMENTS

Do not install mixed materials in wind in excess of 10 mph or when temperature is below 40° F.

1.5 QUALITY ASSURANCE

Perform work in accordance with state and local standards in conjunction with requirements specified herein.

1.6 SUBMITTALS

- A. Submit a sample of each material to be used in a 10 pound air tight container to the testing laboratory.
- B. Submit the name of each materials supplier and specific type and source of each material. Any change in source throughout the job requires approval of the owner or engineer.
- C. Submit mix design and materials mix ratio that will achieve specified requirements for soil stabilization of state and local agencies.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Quicklime or Hydrated Lime
- B. Portland Cement
- C. Fly Ash
- D. Coarse Aggregate
- E. Fine Aggregate

SOIL STABILIZATION
SECTION # 31 32 00-1

- F. Subsoil: Existing Reused
- G. Geotextile Fabric for Stabilization
 - 1. Mirafi 500X or 600X
 - 2. Phillips 66 Supac 6WS
 - 3. Dupont Tyvar 3401 and 3601
 - 4. Trevira S1114 and S1120
 - 5. Tensar SS-1 and SS-2
 - 6. Exxon GTF-200 or 350

2.2 EQUIPMENT

Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidation and compaction of material.

PART 3 EXECUTION

3.1 PREPARATION

- A. Obtain Engineers approval of the mix design before proceeding with the placement.
- B. Do not start stabilization without weather and soil conditions being favorable for the successful application of the proposed material.
- C. Proof roll subgrade to identify areas in need of stabilization.

3.2 EXCAVATION

- A. Excavate subsoil to a depth sufficient to accommodate soil stabilization.
- B. Remove lumped subsoil, boulders and rock that interferes with achieving uniform subsoil conditions.

3.3 SOIL TREATMENT AND BACKFILLING

- A. Lime Stabilized Subgrade: Where indicated on Drawings, treat prepared subgrade with hydrated lime in accordance with applicable state highway specification. Compact to not less than 95% of optimum density as determined by ASTM D 698 (or 92% of the optimum density, in accordance with ASTM D 1557).
- B. Cement Stabilized Subgrade: where indicated on Drawings, treat prepared subgrade with portland cement in accordance with applicable state highway specification. Compact to not less than 95% of optimum density as determined by ASTM D 698 (or 92% of the optimum density, in accordance with ASTM D 1557).
- C. Fly Ash Stabilized Subgrade: where indicated on Drawings, treat prepared subgrade with fly ash in accordance with applicable state highway specification. Compact to not less than 95% of optimum density as determined by ASTM D 698 (or 92% of the optimum density, in accordance with ASTM D 1557).
- D. Maintain optimum moisture of mix materials to attain required stabilization and compaction.
- E. Finish subgrade surface in accordance with Section 31 14 00.

3.4 GEOTEXTILE FABRIC

- A. Place fabric in those areas that are shown on the plans or in those areas that need additional stabilization prior to the placement of the base course.
- B. Place fabric specified in the plans and specifications in accordance with the manufacturers recommendations.

END OF SECTION # 31 32 00

SECTION 31 35 00 - SLOPE PROTECTION AND EROSION CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary and permanent erosion control systems.
- B. Slope Protection Systems.

1.2 RELATED SECTIONS

- A. Section 31 10 00 - Site Preparation
- B. Section 31 14 00 - Earthwork
- C. Erosion Control Plan
- D. Construction Drawings

1.3 ENVIRONMENTAL REQUIREMENTS

- A. The contractor shall protect adjacent properties and water resources from erosion and sediment damage throughout the life of the contract.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Quick growing grasses such as wheat, rye or oats.
- B. Hay or straw bales.
- C. Fencing for siltation control as specified on the plans.
- D. Curlex blankets by American Excelsior Company or approved equal.
- E. Bale stakes for each bale shall be a minimum of 4 feet in length and shall be either 2 #4 rebars, 2 steel pickets or 2-2"x2" hardwood stakes driven 1'-6" to 2'-0" into ground.
- F. Temporary mulches such as loose hay, straw, netting, wood cellulose or agricultural silage.
- G. Fence stakes shall be metal stakes a minimum of 8 feet in length.
- H. RipRap (See Section 31 14 00)

PART 3 EXECUTION

3.1 PREPARATION

- A. Review site erosion control plan.
- B. Deficiencies or changes in the erosion control plan as it is applied to current conditions will be brought to the attention of the Owner and the Engineer for remedial action.

3.2 EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION

- A. Place erosion control systems in accordance with the erosion control plan.
- B. The Owner has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct the contractor to provide immediate permanent or temporary pollution control measures. The contractor will be required to incorporate all permanent erosion control features into the project at the earliest practical time to minimize the need for temporary controls. Cut slopes shall be permanently seeded and mulched as the excavation proceeds to the extent considered desirable and practical.
- C. The temporary erosion control systems installed by the contractor shall be maintained as directed by the Owner to control siltation at all times during the life of the -contract. The contractor must respond to any maintenance or additional work ordered by the Owner within a 48 hour period.

- D. Any additional material and work required and authorized by the Owner which is beyond the extent of the erosion control plan shall be paid for by the owner.
- E. Slopes that erode easily shall be temporary seeded as the work progresses with a wheat, rye or oats application.

3.3 STORM WATER POLLUTION PREVENTION PLAN (SWP3)

- A. Prepare and submit Notice of Intent (NOI) to Texas Commission of Environmental Quality (TCEQ).
- B. The general contractor shall prepare a SWP3 in accordance with all requirements of TXR 150000 and submit to the Architect for review and approval prior to commencing anywork.
- C. The general contractor shall implement the SWP3 through completion of the work.

END OF SECTION # 31 35 00

SECTION 316329 DRILLED CONCRETE PIERS AND SHAFTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Machine drilled shaft.
 - 2. Placing shaft liner.
 - 3. Shear rings.
 - 4. Concrete fill.
 - 5. Reinforcement.
- B. Related Sections:
 - 1. Section 032000 - Concrete Reinforcement: Requirements for concrete reinforcement.
 - 2. Section 033000 - Cast-In-Place Concrete.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 336.1 - Reference Specification for the Construction of Drilled Piers.
- B. ADSC - The International Association of Foundation Drilling:
 - 1. ADSC TL-4 - Drilled Shafts: Construction Procedures and Design Methods.
- C. ASTM International:
 - 1. ASTM A252 - Standard Specification for Welded and Seamless Steel Pipe Piles.
 - 2. ASTM D1143 - Standard Test Method for Piles Under Static Axial Compressive Load.
 - 3. ASTM D4380 - Standard Test Method for Density of Bentonitic Slurries.
 - 4. ASTM D4381 - Standard Test Method for Sand Content by Volume of Bentonitic Slurries.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Store and handle controlled slurry materials in accordance with manufacturers instructions.
- C. Mix, store, and transport controlled slurry materials using equipment made for this purpose.

PART 2 PRODUCTS

2.1 DRILLED CONCRETE PIERS AND SHAFTS

- A. Concrete Materials and Mix: Specified in Section 033000.
- B. Reinforcement: Specified in Section 032000.
- C. Equipment: Appropriate to dewater excavated shaft.
- D. Controlled Slurry:
 - 1. Use controlled bentonite or polymer slurry only at locations specified or indicated on Drawings.
 - 2. Bentonite and Polymer Materials: Suitable for intended purpose according to manufacturer.
 - 3. Controlled Slurry Properties:

| Properties | Results at 68°F | Test Methods |
|--|---------------------------------|--|
| Density, before concreting, for slurry 1 ft from pier bottom | 64 pcf max. for polymer slurry | API 13B, Section 1 (Mud Balance) |
| | 85 pcf max for bentonite slurry | ASTM D4380 |
| Marsh funnel viscosity, for entry slurry and pier slurry | 26-50 sec/qt | API 13B, Section 2 (Marsh Funnel and Cup) |
| Sand content by volume, before concreting for slurry 1 ft from pier bottom | 1% max for polymer slurry | API 13B, Section 4 (Sand Screen Set) |
| | 25% max for bentonite slurry | ASTM D4381 |
| pH, during excavation | 8-12 | API 13B, Section 6 (Paper test strips or glass-electrode pH meter) |

- 4. Provide physical or chemical treatment of water or slurry necessary to meet specified requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify site conditions are ready for Work of this section.

3.2 PREPARATION

- A. Use placement method that will not cause damage to nearby structures.
- B. Document existing conditions for existing structures susceptible to damage:

1. Before move, inspect existing structure thoroughly and notify Architect/Engineer in writing of visible defects and factors capable of affecting safe movement of structure to final location.
 2. Compile list of existing visible defects to building structure, finishes, and accessories. This list will form basis for determining required repair Work after move.
- C. Notify adjacent and affected land owners and building occupants within 14 days before proceeding with the Work.
- D. Notify utility companies to mark location of existing underground services. Do not begin work of this section until existing underground services are marked.
- E. Provide survey benchmarks and control points before beginning construction of piers.
- F. Protect underground utilities and structures near the Work, from damage.

3.3 INSTALLATION

- A. Drill vertical pier shafts to diameters and depths indicated.
- B. Place steel liners immediately after drilling. Set firmly in place. Use shaft liner when free water is encountered.
- C. Clean shaft and bottom of loose material. Maintain shafts free of water.
- D. Allow inspection of shaft and liner prior to placement of reinforcement and concrete.
- E. Provide dowels for connection of caps and grade beams.
- F. Concreting: In accordance with Section 03300 and the following requirements:
1. General:
 - a. Do not place concrete before Architect/Engineer has inspected pier.
 - b. Inspect piers before concreting, to verify loose material within pier has been removed.
 - c. Place concrete immediately after completion of cleaning operation and inspection. When concreting is postponed, repeat cleaning and inspection.
 - d. Place concrete in one continuous operation without cessation from bottom of pier to cut-off elevation to ensure complete homogeneity of concrete throughout pier with no possibilities of cavities, air pockets, honeycombing or cold joints forming in concrete.
 - e. Concrete Slump Dry Method: 5 to 6 inches.

3.4 DRILLING TOLERANCES

- A. Section 014000 - Quality Requirements Tolerances.
- B. Tolerances for deviations from design position, orientation and elevation:
1. Maximum Deviation from Position at Top of Shaft: 3 inches.
 2. Maximum Deviation of Pier Shaft Radius at Bottom of Shaft: Minus 0 inches.

- 3. Maximum Deviation of Pier Cut-Off Elevations: Plus 1 inch and minus 3 inches.
- C. Furnish corrective design and construction required to accommodate deviations exceeding specified tolerances, including replacement of piers, when necessary.

3.5 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Testing and Section inspection services.
- B. Engage licensed surveyor to perform survey work specified in this section, including survey of design and actual pier locations, and plumbness.
- C. Monitor benchmarks and survey control points for displacement during construction. Correct or replace displaced survey controls. Verify previous measurements relying on displaced controls.
- D. Submit survey information as the Work progresses, to expedite construction operations.
- E. Contractor Supervision: Provide supervision of each phase of drilled pier construction. Check each drilled pier or shaft for required depth, clean-up, workmanship, and for tolerance requirements before concrete is placed.
- F. Unacceptable Piers: Piers that fail, are placed out of position, exceed allowable tolerances, have defect inclusions, or are damaged.
- G. Provide additional piers or replace piers failing to conform to specified requirements.

END OF SECTION 316329

SECTION 32 11 00 - PAVING BASE COURSE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Granular Base
- B. Caliche Base
- C. Full Depth Asphalt Base
- D. Hot-Mix Sand Asphalt Base
- E. Soil Cement Stabilized Base

1.2 RELATED SECTIONS

- A. Section 31 10 00 - Site Preparation
- B. Section 31 14 00 - Earthwork
- C. Section 31 20 00 - Aggregate Materials
- D. Section 31 32 00 - Soil Stabilization
- E. Section 32 12 00 - Asphaltic Concrete Paving
- F. Section 32 13 00 - Portland Cement Concrete Paving
- G. Section 32 16 00 - Curbs and Sidewalk
- H. Construction Drawings

1.3 REFERENCES

- A. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- B. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- C. ASTM D2167 - Test Method for Density and Unit Weight of Soil in-place by the Rubber Balloon Method.
- D. ASTM D1556 - Test Method for Density of Soil in-place by the Sand-Cone Method.
- E. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in-place by Nuclear Methods (Shallow Depth), Method 8 (Direct Transmission).
- F. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. Submit materials certificate to on-site independent testing laboratory which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

PART 3 EXECUTION

3.1 EXAMINATION

Contractor shall verify that the subgrade has been inspected, tested and the gradients and elevations are correct, dry and properly prepared.

3.2 CONSTRUCTION

- A. Perform base course construction in a manner that will drain surface properly at all times and at the same time prevent runoff from adjacent areas from draining onto base course construction.
- B. Compact base material to not less than 98% of optimum density as determined by ASTM D 698 or 95% of optimum density, as determined by ASTM D 1557, unless otherwise indicated on the Drawings.

- C. Granular Base: Construct to thickness indicated on Drawings. Apply in lifts or layers not exceeding 8", measured loose.
- D. Caliche Base; Construct to thickness indicated on Drawings. Use 'Type E, Grade 4 Caliche per TXDOT Spec. Item 247.
Flexible base Type E will be composed of caliche (argillaceous Limestone, calcareous or calcareous clay particles) and may contain stone, conglomerate, gravel, sand or granular materials when these materials are I situ with the caliche.

Flexible base (TY E GR 4) shall conform to the following requirements:

| Retained on Sq. Sieve | Percent Retained |
|---------------------------|--------------------------------|
| 2" | 0 |
| 1/2" | 20-60 |
| No. 4 | 40-75 |
| No. 40 | 70-90 |
| Max. PI: | 15 |
| Max. Wet Ball PI: | 15 |
| Wet Ball Mill Max Amount: | 50 |
| Min. Comp. Strength PSI: | 150 at 15 PSI lateral pressure |
| Triaxial Test | Tex-117-E |

The Wet Ball Test (Tex-116-E) shall be run and the Plasticity Index of the material passing the No. 40 sieve shall be determined (Wet Ball PI).

Two (2) percent lime by weight may be incorporated into the Flexible Base in the field at the Owner/Engineer's direction and will be paid for at the amount bid.

The percent of density as determined by Compaction Ratio (Tex-113-E) for the new Flexible Base shall be a minimum of 98%.

For water added under Item 247, the sulfate content will not exceed 3000-ppm and the chloride content will not exceed 3000-ppm.

- E. Asphalt Institute Type IV Mix for Full Depth Asphalt Base: Construct to thickness indicated on Drawings in lifts or layers not exceeding 3", measured loose.
- F. Asphalt Institute Type VI, VII, or VIII Mixes for Hot-mix Sand Asphalt Bases: Construct to thickness indicated on Drawings. Apply in lifts or layers not exceeding 3", measured loose.
- G. Soil Cement Stabilized Base: Construct to thickness and strength as indicated on Drawings and in accordance with applicable state highway specifications. If not indicated on the Drawings, the minimum compressive strength shall be 500 p.s.i., tested at 28 days.

3.3 FIELD QUALITY CONTROL

- A. An Independent Testing Laboratory, selected and paid by owner, shall be retained to perform construction testing of in-place base courses for compliance with requirements for thickness, compaction, density and tolerance. Paving base course tolerances shall be verified (by rod and level readings on not more than fifty-foot centers) to be not more than 0.05 feet above design elevation which will allow for paving thicknesses as shown in the Drawings. Contractor shall provide instruments and a suitable benchmark.
- B. The following tests shall be performed on each type of material used as base course material:
1. Moisture and Density Relationship: ASTM D 698 or ASTM D 1557.
 2. Mechanical Analysis: AASHTO T-88.
 3. Plasticity Index: ASTM D-4318.
 4. Base material thickness: Perform one test for each 20,000 square feet of in-place base material area.
 5. Base material compaction: Perform one test in each lift for each 20,000 square feet of in-place base material area.
 6. Test each source of base material for compliance with applicable state highway specifications.
- C. Field density tests for in-place materials shall be performed according to one of the following standards as part of construction testing requirements:

PAVING BASE COURSE SECTION # 32 11 00-2

1. Sand-Cone Method: AS7M D 1556.
 2. Balloon Method: ASTM D 2167.
 3. Nuclear Method: ASTM D 2922, Method B (Direct Transmission).
- D. Independent Testing Laboratory shall prepare test reports that indicate test location, elevation data, and test results. The Owner, Engineer, and Contractor shall be provided with copies of reports within 96 hours of time test was performed. In event that any test performed fails to meet these Specifications, the Owner, Engineer and Contractor shall be notified immediately by Independent Testing Laboratory. The Owner reserves right to employ Independent Testing Laboratory and to direct any testing that is deemed by them to be necessary. Contractor shall provide free access to site for testing activities.

END OF SECTION # 32 11 00

SECTION 32 12 00 - ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Asphaltic concrete paving; surface course, binder course and base course.

1.2 RELATED SECTIONS

- A. Section 31 22 00 - Excavation, Backfill and Compacting for Pavement
- B. Section 32 13 00 - Paving and Surfacing
- C. Section 32 11 00 - Paving Base Course
- D. Section 32 13 00- Portland Cement Concrete Paving
- E. Section 32 16 00 - Curbs
- F. Section 32 17 23 - Parking Lot and Roadway Marking
- G. Construction Drawings
- H. State Highway Department Standard Specifications

1.3 SUBMITTALS

- A. Design Mix: Before any asphaltic concrete paving is constructed, submit actual design mix to the Owner's Construction Department for review and/or approval. Design mix submittal shall follow the format as indicated in the Asphalt Institute Manual MS-2, Marshall Stability Method; and shall include the type/name of the mix, gradation analysis, grade of asphalt cement used, Marshall Stability (lbs.), flow, effective asphalt content (percent), and direct references to the applicable highway department specifications sections for each material. The design shall be for a mixture listed in the current edition of the applicable state roadway specifications. Mix designs over three (3) years old will not be accepted by the owner.
- B. Material Certificates: Submit materials certificate to on-site independent testing laboratory which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

1.4 JOB CONDITIONS

- A. Weather Limitations:
 - 1. Apply prime and tack coats when ambient temperature is above 40° F, and when temperature has been above 35° F for 12 hours immediately prior to application. Do not apply when base is wet, contains excess moisture, or during rain.
 - 2. Construct asphaltic concrete paving when atmospheric temperature is above 40° F.

1.5 REFERENCES

- A. MS-2-Mix design methods for asphaltic concrete and other hot mix types per The Asphalt Institute (AI)
- B. MS-3-Asphalt Plant Manual per The Asphalt Institute (AI)
- C. Hot Mix Asphalt Paving Handbook per US Army Corp of Engineers, UN-13 (CE MP-ET)
- D. MS-19-Basic Asphalt Emulsion Manual per The Asphalt Institute (AI)
- E. ASTM D946 - Penetration - Graded Asphalt Cement for use in Pavement Construction
- F. AASHTO M-226/ASTM D3381 Asphalt Cement
- G. AASHTO M-140/ASTM D997 or AASHTO M-208/ASTM D-2397 Tack Coat
- H. AASHTO M-117/ASTM D242 Mineral Filler
- I. AASHTO T-245/ASTM D1559 Marshall Mix Design

PART 2 PRODUCTS

2.1 MATERIALS

- A. Provide asphalt-aggregate mixture as recommended by local or state paving authorities to suit project conditions. Use locally available materials and gradations which meet state highway specifications and exhibit satisfactory records of previous installations.
- B. Asphalt Cement: Comply with AASHTO M-226/ASTM D 3381; Table 2 AC-10, AC-20, or AC-30, viscosity grade, depending on local mean annual air temperature. (See chart below):

| <u>Temperature Condition</u> | <u>Asphalt Grades</u> |
|--|-----------------------|
| Cold, mean annual air temperature at 7 degrees C (45 degrees F) or lower | AC-10 85/100 pen. |
| Warm, mean annual air temperature between 7 degrees C (45 degrees F) and 24 degrees C (75 degrees F) | AC-20 60/70 pen. |
| Hot, mean annual air temperature at 24 degrees C (75 degrees F) or higher | AC-30 |

- C. Prime Coat: A medium curing cut-back asphalt or an asphalt penetrating prime coat consisting of either MC-30 or SS-1h.
- D. Tack Coat: Emulsified asphalt; AASHTO M-140/ASTM D 997 or AASHTO M 208/ASTM D 2397, SS-1h, CSS-1, or CSS-1h, diluted with one part water to one part emulsified asphalt.
- E. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M-17/ASTM D 242, if recommended by applicable state highway standards.
- F. Asphalt-Aggregate Mixture: Unless otherwise noted on the Drawings, the Design Mix shall have a minimum stability based on 50-blow Marshall complying with ASTM D 1559 of 1000 lb with a flow between 8 and 16.

The Design Mix shall be within sieve analysis and bitumen ranges below:

SIEVE ANALYSIS OF MIX

| <u>Square Sieve</u> | <u>Total Percent Passing</u> | <u>Percent Tolerance</u> |
|---------------------|------------------------------|--------------------------|
| 3/4" | 100 | 7% |
| 1/2" | 80 - 100% | 5% |
| 3/8" | 65 - 93% | 4% |
| #8 | 40 - 55% | 4% |
| #50 | 12 - 27% | 2% |
| #200 | 0 - 10% | 0% |

Percent bitumen by weight of total mix: 5.0 - 8.5.

Air voids: 3-6%.

Percent aggregate voids filled with asphalt cement: 70 - 82%.

Allowable variance of percent bitumen by weight of total mix = 0.4

2.2 EQUIPMENT

Maintain equipment in satisfactory operating condition and correct breakdowns in a manner that will not delay or be detrimental to progress of paving operations.

PART 3 EXECUTION

3.1 PREPARATION

ASPHALTIC CONCRETE PAVING SECTION # 32 12 00-2

- A. Remove loose material from compacted base material surface immediately before applying prime coat.
- B. Proof roll prepared base material surface to check for areas requiring additional compaction and areas requiring removal and recompaction.
- C. Do not begin paving work until deficient base material areas have been corrected and are ready to receive paving.

3.2 APPLICATIONS

A. Prime Coat:

- 1. Apply bituminous prime coat to all base material surfaces where asphaltic concrete paving will be constructed.
- 2. Apply bituminous prime coat in accordance with APWA Section 2204 and applicable state highway specifications.
- 3. Apply at minimum rate of 0.25 gallon per square yard over compacted base material. Apply to penetrate and seal, but not flood surface.
- 4. Make necessary precautions to protect adjacent areas from overspray.
- 5. Cure and dry as long as necessary to attain penetration of compacted base and evaporation of volatile substances.

Tack Coat:

- 1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.
- 2. Apply tack coat to asphaltic concrete base course or sand asphalt base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphaltic concrete and sand asphalt bases and on surface of all such bases where asphaltic concrete paving will be constructed.
- 3. Apply emulsified asphalt tack coat in accordance with APWA Section 2204 and applicable state highway specifications.
- 4. Apply at minimum rate of 0.05 gallon per square yard of surface.
- 5. Allow to dry until at proper condition to receive paving.

3.3 ASPHALTIC CONCRETE PLACEMENT

- A. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum temperatures:
 - 1. When ambient temperature is between 40° F and 50° F, mixture temp. = 285° F
 - 2. When ambient temperature is between 50° F and 60° F, mixture temp. = 280° F
 - 3. When ambient temperature is higher than 60° F, mixture temp. = 275° F
- B. Whenever possible, all pavement shall be spread by a finishing machine; however, inaccessible or irregular areas may be placed by hand methods. The hot mixture shall be spread uniformly to the required depth with hot shovels and rakes. After spreading, the hot mixture shall be carefully smoothed to remove all segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be of the type designed for use on asphalt mixtures. Loads shall not be dumped faster that they can be properly spread. workers shall-not stand on the loose mixture while spreading.
- C. Paving Machine Placement: Apply successive lifts of asphaltic concrete in transverse directions with the surface course placed in the direction of surface-water flow. Place in typical strips not less than 10'- 0" wide.
- D. Joints: Make joints between old and new pavements, or between successive days and work in a manner that will provide a continuous bond between adjoining work. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete course. Clean contact surfaces of all joints and apply tack coat.

3.4 ROLLING AND COMPACTION

ASPHALTIC CONCRETE PAVING SECTION # 32 12 00-3

- A. The mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of the rollers without undue displacement. The number, weight, and types of rollers and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in a workable condition
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 FIELD QUALITY CONTROL

- A. Independent Testing Laboratory, selected and paid by Owner, shall be retained to perform construction testing of in-place asphaltic concrete courses for compliance with requirements for thickness, compaction and surface smoothness. Asphaltic surface and base courses shall be randomly cored at a minimum rate of one core for every 20,000 square feet of paving. However, no less than three cores in light duty areas and three cores in heavy duty areas shall be obtained. Coring holes shall be immediately filled with full-depth asphalt or with concrete. Asphaltic Concrete pavement samples shall be tested for conformance with the mix design.
- B. Grade Control: Establish and maintain required lines and elevations.
- C. Thickness: In-place compacted thickness shall not be less than thickness specified on the drawings. Areas of deficient paving thickness shall receive a tack coat and a minimum 1" overlay; or shall be removed and replaced to the proper thickness, at the discretion of the Owner; until specified thickness of the course is met or exceeded at no additional expense to the Owner.
- D. Surface Smoothness: Testing shall be performed on the finished surface of each asphalt concrete course for smoothness, using 10'-0" straightedge applied parallel with, and at right angles to centerline of paved area. The results of these tests shall be made available to the owner upon request. Surfaces will not be acceptable if the following 10' straightedge tolerances for smoothness are exceeded.
 - Base Course Surface: 1/4"
 - Wearing Course Surface: 3/16"
- E. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.
- F. Compaction: Field density test for in place materials shall be performed by examination of field cores in accordance with one of the following standards:
 - 1. Bulk specific gravity of paraffin-coated specimens: ASTM D-1188.
 - 2. Bulk specific gravity using saturated surface-dry specimens: ASTM D-2726.Rate of testing shall be one core per 20,000 square feet of pavement, with a minimum of 3 cores from heavy-duty areas and 3 cores from standard-duty areas. Cores shall be cut from areas representative of the project.
Areas of insufficient compaction shall be delineated, removed, and replaced in compliance with the specifications at no expense to the Owner.

END OF SECTION # 32 12 00

ASPHALTIC CONCRETE PAVING
SECTION # 32 12 00-4

SECTION 32 13 00 - PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete, integral curbs, median barriers, parking areas and roads.

1.2 RELATED SECTIONS

- A. Section 31 10 00 - Site Preparation.
- B. Section 31 20 00 - Aggregate Material.
- C. Section 32 11 00- Paving Base Course.
- E. Section 32 16 00 - Curbs and Sidewalk.
- F. State Highway Department Standard Specifications.
- G. Construction Drawings.

1.3 REFERENCES

- A. ACI 301 - Specifications for Structural Concrete for Buildings.
- B. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- C. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
- D. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
- E. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural construction.
- F. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- G. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
- H. ASTM C33 - Concrete Aggregates.
- I. ASTM C94 - Ready Mix Concrete.
- J. ASTM C150 - Portland Cement
- K. ASTM C260 - Air-Entraining Admixtures for Concrete.
- L. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- M. ASTM C494 - Chemical Admixtures for Concrete.
- N. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.

1.4 PERFORMANCE REQUIREMENTS

- A. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Coat forms with non-staining type coating that will not discolor or deface surface of concrete.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets, not rolls, unless otherwise acceptable to Owner.
- C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 40.
- D. Concrete Materials: Comply with requirements applicable for concrete materials, admixtures, bonding materials, curing materials, and others as required.
- E. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D 1751 FS HH-F-341, Type II, Class A; or AASHTO M 153, Type I.

- F. Joint Sealants: Non-priming, pourable, self-leveling polyurethane. Acceptable sealants are Sonneborn "Sonolastic Paving Joint Sealant, Sonneborn "Sonomeric CT 1 Sealant", Sonneborn "Sonomeric CT 2 Sealant", Mameco "Vulken 4511, or Woodmont Products "Chem-Caulk".

2.2 MIX DESIGN AND TESTING

- A. Concrete mix design and testing shall comply with requirements.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce the following properties:
1. Compressive Strength: 3,500 psi, minimum at 28 days, unless otherwise indicated on the Drawings.
 2. Slump Range: 3"-5" at time of placement
 3. Air Entrainment: 5% to 8%.

PART 3 EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared base material surface to check for unstable areas. The paving work shall begin after the unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.
- B. Surface Preparation: Remove loose material from compacted base material surface to produce a firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

- A. Form Construction
1. Set forms to required grades and lines, rigidly braced and secured.
 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place a minimum of 24 hours after concrete placement.
 3. Check completed formwork for grade and alignment to following tolerances:
Top of forms not more than 1/8" in 10'-0".
Vertical face on longitudinal axis, not more than 1/4" in 10'-0".
 4. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Reinforcement: Locate, place and support reinforcement.
- C. Concrete Placement
1. Comply with applicable requirements.
 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at the required finish elevation and alignment.
 3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint
- D. Joint Construction: Construct expansion, weakened-plane Control (contraction), and construction joints straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline, unless otherwise detailed.
1. Weakened-Plane Control (Contraction) Joints: Provide joints at a spacing of 15'-0" o.c. maximum each way. Construct control joints for depth equal to at least 1/4 concrete thickness, as follows:
 - a. Form tooled joints in fresh concrete by grooving top portion with recommended tool and finishing edges with jointer.
 - b. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.

2. Construction Joints: Place concrete joints at end of placements and at locations where placement operations are stopped for period of more than 1/2 hour, except where such placements terminate at expansion joints. Construct joints using standard metal keyway-section forms.
 3. Expansion Joints: Locate expansion joints at 180'-0" o.c. maximum each way. Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks, and other fixed objects.
- E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2" or more than 1/4" below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.
- F. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.

3.3 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of slabs, gutters, back top edge of integral curb, and formed joints with an edging tool, and round to 1/2" radius. Eliminate tool marks on concrete surface. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
1. Inclined Slab Surfaces: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to line of traffic.
 2. Paving: Provide coarse, nonslip finish by scoring surface with stiff-bristled broom perpendicular to line of traffic.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in the "water-curing" section of ACI 308-81.

3.4 CLEANING AND ADJUSTING

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement when construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

3.5 FIELD QUALITY CONTROL

An independent testing laboratory shall randomly core the pavement at a minimum rate of one core per 20,000 square feet of pavement, with a minimum of 3 cores from heavy-duty areas and 3 cores from standard duty areas. Core shall be tested for thickness and quality of aggregate distribution. Core holes shall be patched immediately with portland cement concrete conforming to section 2.02 and shall be finished to provide a level surface conforming to section 3.03 A & 3.03 B.

END OF SECTION # 32 13 00

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Concrete paving, including, but not limited to parking lots, aprons, sidewalks, curbs, handicapped accessible ramps, approaches, and miscellaneous exterior concrete shown on drawings.
- B. Traffic lane and parking space paint striping, including, but not limited to painting of curbs and stenciling of signs stipulating FIRE LANES, NO PARKING and BUS LOADING areas, crosswalks, handicapped accessible parking spaces, and other areas shown on drawings or required by authorities having jurisdiction.
- C. Precast concrete wheel stops and accessories shown on drawings.

1.3 RELATED WORK

- A. Section 01 45 23 - Testing and Inspecting Services.
- B. Section 02 32 00 - Geotechnical Report.
- C. Section 03 30 00 - Cast-In-Place Concrete.
- D. Section 31 00 00 - Earthwork (Under Paving and Site Appurtenances).
- E. Section 31 23 16.13 - Trench Safety System.
- F. Section 31 32 13 - Hydrated Lime and Lime Slurry.
- G. Section 31 32 13.16 - Cement Stabilized Sand Bedding and Backfill.
- H. Section 32 11 13 - Lime Stabilized Subgrade.
- I. Section 33 00 00 - Construction of Underground Utilities.

1.4 QUALITY ASSURANCE

- A. Where standards or requirements of this Section are in conflict with those noted on the Contract Drawings, or the Building Code, the more stringent requirements shall govern. Bring all conflicts and discrepancies to the attention of the Architect and do not start work until such conflicts and discrepancies are clarified and corrected. Failure to do so will not relieve the Contractor from performing the Work correctly at no additional expense to the Owner.
- B. Testing Laboratory Services:
 - 1. Test results shall meet or exceed established standards. A technician from the Owner's Testing Laboratory must be present during all operations.

1.5 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. M-90
 - 2. M-213
- B. American Concrete Institute (ACI)
 - 1. 305, Hot Weather Concreting
 - 2. 306, Cold Weather Concreting
- C. ASTM International (ASTM)
 - 1. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 2. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 3. C33, Standard Specification for Concrete Aggregates
 - 4. C94, Standard Specification for Ready-Mixed Concrete
 - 5. C150, Standard Specification for Portland Cement
 - 6. C260, Standard Specification for Air-Entraining Admixtures for Concrete
 - 7. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - 8. C494, Standard Specification for Chemical Admixtures for Concrete
 - 9. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 - 10. C920, Standard Specification for Elastomeric Joint Sealants
 - 11. C979, Standard Specification for Pigments for Integrally Colored Concrete
- D. Federal Specifications (FS)
 - 1. TT-S-00227E, Elastomeric Joint Sealants
 - 2. TT-P-1952B, Traffic and Airfield Marking Paint, Water Emulsion Base

1.6 PROJECT CONDITIONS

- A. Do not place concrete in contact with frozen earth. Do not commence concrete placement unless temperature is at least 35 degrees F and rising, or slabs until the temperature rises above 40 degrees F.
- B. Discontinue concrete placement when air temperatures exceed 100 degrees F.
- C. Dispose of any concrete that exceeds 95 degrees F as determined by Architect in field.
- D. Do not place concrete during rain.
- E. Cold Weather Placing: Comply with ACI 306 to protect all concrete work from physical damage and reduce strength caused by frost, freezing actions, or low temperatures. Place no concrete against frozen earth.
- F. Hot Weather Placing: Prepare aggregates, mix water and other ingredients, and place, cure, and protect concrete in accordance with the requirements of ACI 305.
- G. Do not apply traffic or zone marking paint on wet or damp surfaces or when rain is imminent. Do not commence painting operations until material, air, and/or surface temperature and dew point are within paint manufacturer's recommended application limits.

1.7 SUBMITTALS

- A. Product Data: Manufacturer's descriptive literature for concrete admixtures.
- B. Shop Drawings: Show locations and installation procedures. Include details of joints, accessories, reinforcement, and clearances. Include concrete placement sequence schedule.
- C. Concrete Design Mix Reports:
 - 1. One (1) for each type of concrete to be used.

1.8 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01110 - Notification of Architects Requirements
- B. Required Participants:
 - 1. General Contractor Superintendent
 - 2. Placement and Finishing Foreman
 - 3. Concrete Supplier
 - 4. Testing Lab

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Manufacturers named within this Section are approved for use on the Project for the product for which they are specified. Other manufacturers must have a minimum of five (5) years experience manufacturing the product specified and meet or exceed the specifications for that product. Substitution of products must be in accordance with the General Conditions, Supplementary Conditions, and Section 01 33 00, Submittals to be considered prior to proposal.

2.2 MATERIALS

- A. Formwork:
 - 1. General: Contractor may use any of the following formwork materials as long as material meets the following and will not stain, or impart any undesirable texture, i.e. wood grain, where such texture would be objectionable in an exposed location.
 - a. Wood Forms:
 - 1) Plywood: PS 1, Douglas Fir or Spruce species.
 - 2) Medium Density Overlay (MDO): One (1) side grade; sound undamaged sheets with clean, true edges.
 - 3) Lumber: Southern Yellow Pine species; No. 2 grade, with grade stamp clearly visible.
 - b. Pre-Fabricated Forms:
 - 1) Preformed Steel Forms: Minimum 16 gauge matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
 - 2) Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- B. Metal Reinforcement:

1. Bars:
 - a. Conform to ACI 315, latest edition.
 - b. Comply with ASTM A615, Grade 60, deformed billet steel bars, unfinished, except Number 3 bars shall comply with ASTM A615, Grade 40, deformed billet steel bars, unfinished.
 2. Tie Wire: 16 gauge annealed.
- C. Concrete Materials (Other than concrete for extruded curbs, unless noted otherwise)
1. Cement: Type 1, ASTM C150, unless approved otherwise by Architect. Use one (1) brand of cement for entire project.
 2. Concrete Admixtures: Provide admixtures produced and serviced by established, reputable manufacturer and used in compliance with manufacturer's recommendations.
 - a. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures. Provide one (1) of the following, or Architect approved equal:
 - 1) AEA-92 and Air Mix 200 by The Euclid Chemical Co.
 - 2) Sika AEA by Sika Corp.
 - 3) MB-VR or MB-AE by Master Builders, Inc.
 - b. Water-Reducing Admixture: ASTM C494, Type A, and containing not more than 0.05 percent chloride ions. Provide one (1) of the following, or Architect approved equal:
 - 1) Eucon WR 75 or Eucon WR 91 by the Euclid Chemical Co.
 - 2) Pozzolith 322N by Master Builders, Inc.
 - 3) Plastocrete 161 by Sika Chemical Corp.
 - c. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or Type G and containing not more than 0.05 percent chloride ions. Provide one (1) of the following, or Architect approved equal:
 - 1) Eucon 37 by The Euclid Chemical Co.
 - 2) Sikament 300 by Sika Chemical Corp.
 - 3) Rheobuild 1000 by Master Builders, Inc.
 3. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.
 4. Integral Color Pigment (Required for new concrete handicapped accessibility ramps): Mineral oxide, lightfast, lime-proof, water-resistant type conforming to ASTM C979. Color(s) shall be as selected by Architect from manufacturer's standard color line. Provide one (1) of the following, or Architect approved equal:
 - a. ChemSystems, Inc.
 - b. Davis Colors
 - c. New Riverside Ochre Co., Inc.
 - d. L.M. Scofield Company
 5. Aggregates:
 - a. Comply with ASTM C33
 - b. Maximum size not larger than 1/5 of narrowest dimension between forms of the member for which concrete is to be used. Not larger than 3/4 of minimum clear spacing between reinforcing bars.
 - c. 1-1/2 inch maximum in paving slabs.
 6. Strengths:
 - a. Five (5) sack (shall contain no less than 5 sacks of Portland cement)/3,500 psi/28 days.
 - b. Strength recommendations on Drawings supersede when they are greater than specified here.
 7. Water: Drinking quality.
 8. Water - Cement Ratio (lb water per lb of Portland cement):
 - a. 3,500 psi concrete:
 - 1) 0.58 maximum

- 2) 0.46 maximum for air-entrainment
- 9. Slump:
 - a. Slump shall be 4 inches plus or minus 1 inch, unless specifically noted otherwise.
- D. Joints:
 - 1. Tooled Control Joint (C.J.): Scored 1/4 inch wide by 1/4 thickness of concrete in depth.
 - 2. Expansion Joints:
 - a. Fiber Joint Filler/Expansion Joints: Premolded asphalt impregnated rigid fiber board. Comply with AASHTO M-213. Use 3/4 inch thick at expansion joints adjacent to extruded curbs, 1/2 inch thick at perimeter of footings for ground-set items such as bollards and fence posts where such footings are incorporated into slabs; elsewhere as shown.
 - b. Wood Joint Filler/Expansion Joints: Where indicated in the drawing, provide construction clear heart grade redwood joints conforming to AASHTO M-90. Provide sizes indicated on drawings. Do not install adjacent to curbs.
 - 3. Load Transfer Units:
 - a. Light Duty (sidewalk):
3/4 inch thick construction clear heart redwood expansion joint form with minimum one (1) inch deep removable top strip, 1/2 inch by 10 inch smooth steel reinforcing bars at 12 inches o.c. with bond breaker sleeve on one (1) side, and 3/32 inch thick steel bar-support plates each side. Provide custom size as required for full depth of paving and sealant depth as required by sealant manufacturer.
 - b. Medium Duty (Auto) / Heavy Duty (truck/bus traffic): 3/4 inch thick redwood expansion joint form with minimum one (1) inch deep removable top strip, 3/4 inch by 18 inch steel reinforcing bars at 12 inches o.c. with bond-breaker sleeve on one (1) side and 3/16 inch steel bar-support plates each side. Provide custom size as required for full depth of paving and sealant depth as required by sealant manufacturer.
 - 4. Transverse/Longitudinal Construction Joints: 18 gauge preformed galvanized keyway with removable strip.
 - 5. Joint Sealant: Self-leveling silicone base, cold-applied joint sealing compound complying with No. 890-SL Self-Leveling Silicone Joint Sealant as manufactured by Dow Corning, or approved equal.
- E. Accessories:
 - 1. Chairs and Spacers: Heavy-duty plastic-type sized to support all reinforcing steel to proper height directly on properly prepared and compacted subgrade. No sand cushion pads will be permitted. Provide chairs and spacers Series "B" by W.H.C. Products, Inc., E-Z Chair by Aztec Concrete Accessories, Inc., MEDCO PC-4 by Meadow Burke, a Division of MMI Products, GTI Bar Chair by General Technologies, Inc., or approved equivalent. Maximum spacing of chairs shall be 36-inches on center each way.
 - 2. Form Release Agent: Colorless mineral oil which will not stain concrete, or absorb moisture.
 - 3. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages, Fasteners: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
 - 4. Epoxy Adhesive: ASTM C881, two (2) component, 100 percent solids, 100 percent reactive compound suitable for use on dry or damp surfaces. Provide one (1) of the following, or approved equal:
 - a. Euco #452 Epoxy System or Euco #620 Epoxy System by The Euclid Chemical Company

- b. Sikadur Hi-Mod by Sika Corp.
- F. Curing Compound: The compound shall conform to ASTM C309-1315, Type II (A.I.M. Regulations - VOC Compliant). Provide 1600 White by W. R. Meadows, Inc., or equal products by Master Builders, Dayton Superior, or approved equal.
- G. Other Materials: Provide all items required to complete work which is not specified or which is not to be provided by other trades.
- H. Extruded Concrete Curbs:
 - 1. Materials:
 - a. Portland Cement: ASTM C150, Type I.
 - b. Aggregate: ASTM C33.
 - c. Water: Clean, free of contaminating material.
 - 2. Epoxy Adhesive: As specified under concrete materials above.
 - 3. Concrete Mixing:
 - a. Slump: No slump allowed.
 - 4. Curing Compound: As specified under concrete materials above.
- I. Traffic and Zone Marking Paint: (As shown on drawings or required)
 - 1. Type: Latex, water based paint intended for use in marking parking lots and roads and complying with FS TT-P-1952B. Product shall be Setfast Fast Dry Latex Traffic Marking Paint by The Sherwin-Williams Co., Speedhide Traffic and Zone Marking Flat Latex by Pittsburgh Paints, 1450 Latex Traffic Line and Marking Paint by Kelly-Moore paint Co., or approved equal.
 - 2. Stripe Size: Four (4) inches wide for traffic and parking lanes, unless noted otherwise.
 - 3. Colors:
 - a. Traffic and Parking Striping: Yellow or as selected by Architect.
 - b. Fire Lanes: All curbs at driveways adjacent to building shall be painted solid red with white stenciled lettering to read "FIRE LANE, NO PARKING" in size and spacing required by authorities having jurisdiction. Contractor to verify requirements of local jurisdiction for fire lane striping.
 - c. Accessibility Handicapped Parking: Symbols and spaces shall be in size and color in accordance with ADA and TAS authorities having jurisdiction.
- J. Precast Concrete Wheel Stops: (As shown on drawings or required)
 - 1. Precast of 3,000 psi air-entrained concrete, approximately 6 inches high x 9 inches wide x 6 feet-0 inches long, with chamfered top corners and drainage slots underneath. Unit shall weigh minimum 190 lbs.
 - 2. Anchor Rods: Two (2) No. 4 x 12 inch long anchor rods located approximately 12 inches from each end of wheel stop.
 - 3. Epoxy Adhesive: As specified under concrete materials above.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Review approved mix designs with Architect in field.
- B. Clean all mixing and transportation equipment; remove debris from forms; wet forms thoroughly; remove ice and other coatings from reinforcement which might hinder good bond; remove water from place of deposit; and check reinforcement.

- C. Inspection: Examine all areas and conditions under which the Work of this Section will be performed. Correct any conditions detrimental to the approved completion of the work. Do not proceed until all such conditions are corrected.

3.2 INSTALLATION

- A. Forms:
1. Conform to the shapes, lines and dimensions of the members as shown on the drawings, except as modified under the Earthwork Section of these specifications. Review depths with Architect in field.
 2. Care shall be taken to assure that formwork does not stain concrete surfaces.
 3. Slab Block-Outs:
 - a. Diamond configuration at paving drains, round or diamond configuration at bollards, fence posts and the like.
 - b. Coordinate with concrete joints, verify with Architect.
 4. Slope exterior concrete slabs away from building and towards paving drains. Verify all slopes with Architect prior to start of concrete pour.
 5. Form Removal:
 - a. Remove only after concrete has thoroughly hardened.
 - b. Vertical forms for ground-supported slabs may be removed 24 hours after pour.
- B. Reinforcing:
1. Cleaning Reinforcement: Free from rust, scale, dirt, or other coatings which will destroy or reduce the bond.
 2. Placing Reinforcement:
 - a. Place accurately and adequately secure in position.
 - b. Bar reinforcement in all concrete slabs shall be held in proper locations by use of plastic chairs spaced a maximum distance of 36 inches o.c. unless noted otherwise.
 3. Coverage of Reinforcement: The metal reinforcement shall be protected by the thickness of concrete indicated on the plans.
 - a. Three (3) inches: Concrete deposited against ground without use of forms.
 - b. Two (2) inches: Bars more than 5/8 inch diameter where concrete is exposed to the weather, or exposed to the ground but placed in forms.
 - c. 1-1/2 inches: Bars 5/8 inch diameter where concrete is exposed to the weather, or exposed to the ground but placed in forms.
 - d. Two (2) inches: In slabs and walks on grade.
 - e. 1-1/2 inches-1-3/4 inches from top: Paving
- C. Joints:
1. Construction Joints:
 - a. Shall occur at expansion joints and transverse/longitudinal keyway joints in paving as complete pour.
 - b. Use at cold joints in paving slabs.
 - c. Within 48 hours after placing, remove removable strips and seal transverse/longitudinal keyway joints.
 2. Expansion Joints:
 - a. Locate fiber joint filler type where walks and paving abut curbs and at perimeter of slab infill. Joints shall be continuous and full depth and width of slab. Stop 3/4 inch thick fillers 1/2 inch below top of paving and 1/2 inch thick fillers 3/8 inch below top of paving for subsequent application of sealant cap; sealant to be applied to within 1/8 inch of slab surface. Verify other locations with Architect where asphalt impregnated fiber joint filler and sealant cap is to be used.

- b. Locate redwood expansion joints at paving and walk expansion joints where indicated, complete with load transfer units as specified herein and detailed. Joints shall be continuous and full depth and width of slab. Except where detailed without sealant cap, stop expansion joints 1/2 inch below top of paving for subsequent application of sealant cap. Top surface of sealant shall be approximately 1/8 inch below top of adjacent concrete. Install sealant and primer in accordance with manufacturer's instructions. For applications where no sealant cap is to be applied, stop expansion joints minimum 1/8 inch to 1/4 inch maximum below top of paving surface with removable stripping. Verify other locations with Architect where redwood expansion joint and sealer cap is to be used.
 - 3. Load Transfer Units: Install straight and true, and in accordance with manufacturer's instructions.
 - 4. Tooled Joints:
 - a. Steel tool all control joints, edges of expansion joints, and all exposed perimeter edges to smooth bullnose, using an edger having a radius of 1/4 inch, as approved.
 - b. Form control joints in uniform straight lines in locations indicated, but in no case greater than 5 feet apart, uniformly spaced.
- D. Accessories: Install accessories and boxes, sleeves and other required devices furnished by other trades.
- E. Concrete:
- 1. Conveying:
 - a. Batching, mixing and Delivery Equipment: Use transit mixed concrete from approved batching and mixing plant. Batch, mix and transport concrete to the site in accordance with provision of ASTM C94. Where colored concrete is shown or required, i.e. accessible ramps, use color pigment admixture in concrete. Mix color pigment into concrete in accordance with manufacturer's recommendations to achieve integrally pigmented concrete in specified colors or as selected by Architect.
 - b. Handling concrete from point of delivery and transfer to conveying equipment and to location of final deposit as rapidly as practicable and by methods which prevent segregation and loss of mix materials.
 - c. Provide runways for wheeled conveying equipment from delivery point to location of final deposit.
 - d. Keep interior surfaces of conveying equipment, including chutes and tremies, free from hardened concrete, debris, water and other deleterious materials.
 - e. Pumps may be used only if they can pump the mix designed. Do not add fine aggregate or water to the mix to satisfy needs of a pumping device.
 - f. Use chutes or tremies for placing concrete where a drop of more than 6'-0" is required.
 - g. Addition of water on the job - The maximum water-cement ratio should never be exceeded. If all the water allowed by the specification has not been added at the start of mixing, it may be permissible to add the remaining allowable water at the point of delivery.
 - 2. Concrete Placement, General:
 - a. Place concrete in compliance with practices and recommendations of ACI 304, and as specified herein.
 - b. Do not deposit concrete on concrete which has hardened sufficiently to form seams or planes of weakness within the section.
 - c. Sections between expansion joints and construction joints shall be placed in continuous pours; construction joints in paving and walks other than at formed joint locations will not be permitted.

- d. Place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
 - e. Deposit concrete as nearly as practicable in its final location to avoid segregation due to rehandling and flowing. Do not subject concrete to any procedure which might cause segregation.
 - f. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming and grouting.
 - g. Do not use concrete which becomes nonplastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials.
3. Slab Placement:
- a. Moisten subgrade the evening before and immediately prior to placement of all paving slabs.
 - b. Deposit and consolidate concrete slabs in a continuous operation, within the limits of all expansion joints, until the placing of a panel or section is completed using vibrating bridge screeds, roller pipe screeds or other methods acceptable to Architect.
 - c. Consolidate concrete during placement by use of the specified equipment, preferably with power driven floats of impact type, thoroughly working concrete around reinforcement and into corners.
 - d. Bring slab surfaces to correct level with a straight edge, and then strike off.
 - e. Use bullfloats or darbies to smooth the surface, leaving it free from bumps and hollows.
 - f. Do not sprinkle water on the plastic surface; do not disturb the slab surfaces prior to start of finishing operations.
4. Extruded Curb Placement:
- a. Install to detail in locations shown.
 - b. Apply epoxy resin adhesive to paved surface prior to extruding curb.
 - c. Machine extrude concrete to shape detailed on Drawings, as approved. Trowel form concrete curbs in areas where machine cannot reach.
 - d. Install premolded expansion joints where curbs meet poured-in-place concrete and at 60 lineal feet maximum spacing; elsewhere where indicated.
 - e. Cut crack control joints every 20 lineal feet and at beginning of curves with less than five (5) foot radius.
 - f. Hand trowel rough areas to a dense, uniform texture. Bevel curbs 45 degrees at dead ends.
 - g. Spray apply membrane forming curing compound after curb installation.
 - h. Remove and replace curbs which crack; cut out chipped or cracked areas and reinstall new extruded curbs.
 - i. Remove excess concrete from paving surfaces.
- F. Curing:
1. General:
- a. Protect all freshly placed concrete from premature drying and excessive hot or cold temperature extremes. Start curing procedures on slabs immediately after finishing operation.
 - b. Maintain curing procedures for seven (7) days at minimum temperature of 50 degrees F.; if mean daily temperature drops below 40 degrees F. during this period, extend curing period an equal number of days or provide temporary heat or additional protection to maintain specified minimum temperature of air in contact with concrete.
2. Curing Exterior Paving and Slabs: Spray paving, walks, curbs and other miscellaneous slabs with liquid membrane-forming compound specified above, applied at not less than the manufacturer's specified and recommended rate.

- G. Finishes:
1. Spreading of dry cement for finishing is not permitted.
 2. Finish all exposed edges and joints with edging tools of 1/4 inch radius.
 3. Exterior Paving and Slabs:
 - a. Floating: Do not begin floating until bleed water sheen has disappeared or until leveled material has stiffened sufficiently for power floating. After power floating, re-float by hand immediately to uniform, true, smooth, granular surface within the specified tolerance.
 - b. Medium Broom Finish: Broom after floating and concrete is hard enough to retain scoring. Use a stiff fiber or wire broom. Broom perpendicular to direction of traffic, typically. Broom in opposite directions at sidewalk panels in a checkerboard pattern or as indicated on drawings.
 4. Handicapped Accessible Ramps: Slope surfaces as shown on drawings. Texture ramp by providing grooves running perpendicular to direction of slope. Grooves shall be 1/8 inch deep x 1/4 inch wide spaced one (1) inch on centers and running entire width of ramp.
 - a. New Concrete Ramps: Integrally color concrete in color selected by Architect from manufacturer's standard colors to provide contrasting color to that of adjacent concrete.
 - b. Existing Concrete Ramps: Stain concrete using specified concrete stain in color selected by Architect from manufacturer's standard colors to provide contrasting color to that of adjacent concrete.
 - 1) Prior to applying any stain, existing concrete ramps shall be cleaned up of all dirt, oil, grease, and other contaminants.
 - 2) Acid etch with 25 percent muriatic acid solution.
 - 3) Power wash at 3,000 psi.
 - 4) Water test to determine if water absorbs, thereby making it good to stain.
 - 5) Allow concrete to thoroughly dry.
 - 6) Apply stain in accordance with manufacturer's instructions.
 - c. Note: All colors must be approved by Architect prior to their use. Failure to do so, may be cause for rejection of work and removal and replacement of work with new work at Contractor's expense.
 5. Miscellaneous Vertical Surfaces: Finish all vertical surfaces, including but not limited to curbs, risers, low walls and stringer, while concrete is strong enough to stay in place without forms yet green and able to be finished to a homogeneous appearance.
- H. Traffic Lane, Parking Space, and Zone Paint Striping: (As shown on drawings or required)
1. Surface Conditions: Clean and dry, free from dirt, loose paint, oil, grease, wax and other surface contaminants which would affect paint bond.
 2. Allow concrete surfaces to cure the minimum time recommended by the traffic marking paint manufacturer, but in no case less than 30 days prior to applying traffic marking paint.
 3. Locate markings as indicated on drawings. Do not apply paint until layout is verified with Architect. Protect surfaces which are not to receive paint.
 4. Mix paint and apply two (2) unthinned coats to approximately five (5) mils dry film thickness per coat in accordance with manufacturer's instructions, using skilled labor and proper mechanical equipment to produce uniform, straight lines without bleeding edges or runs.
 5. Paint traffic, parking lanes, and accessibility handicapped parking lines as shown on drawings and to comply with requirements of authorities having jurisdiction.
 6. Paint curbs and stenciled signs for FIRE LANES, NO PARKING, and BUS LOADING areas, crosswalks, handicapped accessible parking spaces, and other areas shown on drawings or required by authorities having jurisdiction. Use proper type, style and size stencils for all numbers and lettering. Do not apply paint until

layout is verified with Architect and/or authorities having jurisdiction. Protect surfaces which are not to receive paint.

- I. Precast Concrete Wheel Stops: (As shown on drawings or required)
 1. Surface Conditions: Clean and dry, free from dirt, loose paint, oil, grease, wax and other surface contaminants which would affect epoxy bond.
 2. Locate wheel stops as indicated on drawings.
 3. Predrill holes in concrete paving for anchor rods.
 4. Secure wheel stops in 1/8 inch thick x 3 inch wide epoxy and drive anchor rods through predrilled holes filled with epoxy grout.

3.3 FIELD QUALITY CONTROL

- A. Inspection and Testing laboratory services shall be in accordance with Section 01 45 23, Testing and Inspecting Services.
- B. Except as noted below, all inspection and testing related to concrete placement, including reinforcing and embedded items, shall be the responsibility of the Owner. The Owner will directly engage the services of a qualified Testing and Inspection Laboratory, however, the Contractor shall provide access to the Owner's consultant, and, if required, the Contractor shall provide patching and repairing of surfaces removed to facilitate testing and inspection.
- C. Should the strength of concrete fall below the minimum, then additional tests, including load tests, may be required. These tests, if required, shall be made at the Contractor's expense and shall be in accordance with ASTM C42 and ACI 318. If tests do not meet the applicable requirements, then the structure, or any part of the structure, shall be removed and replaced at the Contractor's expense.
- D. Any concrete testing requested by the Contractor for early formwork or shoring removal, etc., shall be at the Contractor's expense.
- E. Furnish certified reports of each proposed mix for each type of concrete at least 30 days prior to start of installation of the Work of this Section.
- F. Furnish ready mix delivery tickets to field Architect upon request.
- G. Tolerances:
 1. Slope as shown on drawings.
 2. Paving sections containing "bird baths" greater than two (2) feet in diameter and 1/4 inch deep will be removed and repoured at Contractor's expense.

3.4 PATCHING AND CLEANING

- A. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete to approval of Architect.
- B. Reinforce or replace all deficient work as directed by Architect and at no additional cost to Owner.
- C. Clean all concrete and cement work on completion of this portion of the work.

3.5 PENALTY FOR DEFICIENT PAVEMENT THICKNESS

- A. It is the intent of this specification that the pavement be constructed in strict conformity with the thickness and typical sections shown on drawings. Where any pavement is

found not so constructed, the following rules relative to adjustment of payment for acceptable pavement and to replacement of faulty pavement shall govern.

- B. Prior to final acceptance, and if deemed necessary by the Engineer, the pavement will be cored by the Testing Laboratory. Locations of core tests may be selected by the Engineer. Regular testing shall occur for every five hundred (500) square yards of placed concrete pavement and at random locations.
- C. For the purpose of establishing an adjusted price for pavement, units to be considered separately are defined as 500 square yards of pavement.
- D. One core will be taken at locations selected by the Engineer or at random in each unit, and tested in accordance with ASTM Method C-174. When measurement of the core from any unit is not deficient more than 0.2 inches from the plan thickness, full payment will be made.
- E. If measurement of any core from any unit is deficient more than 0.2 inch but not more than 0.50 inch from the plan thickness two (2) additional cores will be taken from the unit and the average of the three cores determined. The two (2) additional cores will be taken such that the unit will be well represented. If the average thickness of the three cores is deficient more than 0.2 inch but not more than 0.50 inch from the plan thickness, an adjusted unit price as provided below, will be paid for in these areas represented by these cores. At the option of the Engineer, additional cores may be taken in the adjacent unit/units to determine if the deficiency of thickness continues across all lanes of pavement. If the deficiency is found to exist in one (1) or more adjacent units, adjusted unit prices as provided below will be paid for those adjacent units that are found to be deficient.

F. Price Adjustments: Concrete Pavement Deficiency

| Deficiency of Thickness Determined by Cores In Inches | Proportional Part of Contract Price Allowed |
|--|--|
| 0.00 to 0.20 | 100 Percent |
| 0.21 to 0.30 | 80 Percent |
| 0.31 to 0.40 | 72 Percent |
| 0.41 to 0.50 | 68 Percent |
| Over 0.50 | 50 Percent or Remove* |

* At the option of the Engineer

- G. Any area of pavement found deficient in thickness by more than 0.50 inch, but not more than 0.75 inch, shall be evaluated by the Engineer. If, in the judgment of the Engineer, the area of such deficiency should not be removed and replaced, there will be no payment for the area retained. If, in the judgment of the Engineer, the area of such deficiency warrants removal, the area shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on the drawings. Any area found deficient in thickness by more than 0.75 inch shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on the drawings.
- H. No additional payment, over the contract price will be made for any pavement of a thickness exceeding that required on the drawings. Also, planing of concrete pavement shall not be allowed.

END OF SECTION 32 13 13

SECTION 32 16 00 - CURB AND SIDEWALKS

PART I GENERAL

1.1 SECTION INCLUDES

- A. Combination concrete curb and gutter
- B. Concrete Curb
- C. Concrete Flume
- D. Concrete Sidewalk

1.2 RELATED SECTIONS

- A. Section 31 10 00 - Site Preparation.
- B. Section 31 20 00 - Aggregate Material.
- C. Section 32 11 00 - Paving Base Course
- D. State Highway Department Standard Specifications.
- E. Construction Drawings.

1.3 REFERENCES

- A. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- B. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural construction.
- C. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- D. AS774 C33 - Concrete Aggregates.
- E. ASTM C94 - Ready Mix Concrete.
- F. AS7M C150 - Portland Cement
- G. AS7M C260 - Air-Entraining Admixtures for Concrete.
- H. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- I. AS7M C494 - Chemical Admixtures for Concrete.
- J. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.

1.4 PERFORMANCE REQUIREMENTS

- A. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. The forms shall be of a depth equal to the depth of curbing or sidewalk, and so designed as to permit secure fastening together at the tops. Coat forms with non-staining type coating that will not discolor or deface surface of concrete.
- B. Concrete Materials: Comply with requirements for concrete materials, admixtures, bonding materials, curing materials, and others as required.
- C. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D 1751 FS HH-F-341, Type II, Class A; or AASHTO M 153, Type I.
- D. Joint Sealers: Non-priming, pourable, self -leveling polyurethane. Acceptable sealants are Sonneborn "Sonolastic Paving Joint Sealant" Sonneborn "Sonomeric CT 1 Sealant", Sonneborn "Sonomeric CT 2 Sealant", Mameco "Vulken 4511, or Woodmont Products "Chem-Caulk".

2.2 MIX DESIGN AND TESTING

- A. Concrete mix design and testing shall comply with requirements.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce the following properties:
 - 1. Compressive Strength: 3,500 psi, minimum at 28 days, unless otherwise indicated on the Drawings.
 - 2. Slump Range: 2"-5" at time of placement.
 - 3. Air Entrainment: 5% to 8%.

PART 3 EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared base material surface to check for unstable areas. The paving work shall begin after any unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.
- B. Surface Preparation: Remove loose material from compacted base material surface to produce a firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION

- A. Form Construction
 - 1. Set forms to required grades and lines, rigidly braced and secured.
 - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place a minimum of 24 hours after concrete placement.
 - 3. Check completed formwork for grade and alignment to following tolerances:
 - Top of forms not more than 1/8" in 10' - 0".
 - Vertical face on longitudinal axis, not more than 1/4" in 10'-0".
 - 4. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Concrete Placement
 - 1. Comply with applicable requirements.
 - 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at the required finish elevation and alignment.
 - 3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of dowels, and joint devices.
 - 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hours, place construction joint. Automatic machine may be used for curb and gutter placement at Contractor's option. machine placement must produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.
- C. Joint Construction
 - 1. Contraction Joints: Concrete curb, concrete gutter or concrete curb and gutter, where specified on the plans, shall be constructed in uniform sections of the length specified on the plans. The joints between sections shall be formed either by steel templates 1/8 inch in thickness, of a length equal to the width of the gutter and/or curb, and with a depth which will penetrate at least 2 inches below the surface of the curb and/or gutter; or with 3/4-inch thick preformed expansion joint filler cut to the exact cross section of the curb and/or gutter; or by sawing to a depth of at least 2 inches while the concrete is between 4 to 24 hours old. If steel templates are used, they shall be left in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

2. Longitudinal Construction Joints: Concrete curb, concrete gutter or combination concrete curb and gutter, where specified on the plans, shall be tied to concrete pavement with 1/2 inch round deformed reinforcement bars of the length and spacing shown on the plans.
 3. Transverse Expansion Joints: Transverse expansion joint in curb, curb and gutter, gutter or sidewalk shall have the filler cut to the exact cross section of the curb, curb and gutter, gutter or sidewalk. The joints shall be similar to the type of expansion joint used in the adjacent pavement.
- D. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2" or more than 1" below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible where more than one length is required, lace or clip joint filler sections together.
- E. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.

3.3 CONCRETE FINISHING

- A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of sidewalks, gutters, back top edge of integral curb, and formed joints with an edging tool, and round to 1/21, radius. Eliminate tool marks on concrete surface. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
1. Inclined Slab Surfaces: Provide coarse, non-slip finish by scoring surface with stiff-bristled broom perpendicular to line of traffic.
 2. Curbs, gutters, and walks: Broom finish by drawing fine-hair broom across surface perpendicular to line of traffic. Repeat operation as necessary to produce a fine line texture.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in the "water-curing" section of ACI 308-81.

3.4 BACKFILL

After the concrete has set sufficiently, the spaces in front and back of the curb and gutter or sidewalk shall be refilled to the required elevation with suitable material which shall be compacted until firm and solid and neatly graded.

3.5 CLEANING AND ADJUSTING

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION # 32 16 00

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Painted pavement marking.
- B. Painted curbs, guard posts and light pole bases.

1.2 RELATED SECTIONS

- A. Section 31 14 00 - Earthwork
- B. Section 32 11 00 - Paving Base Course
- C. Section 32 12 00- Asphaltic Concrete Paving
- D. Section 32 13 00 - Portland Cement Concrete Paving
- E. Construction Drawings

1.3 PROJECT CONDITIONS

- A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs and warning lights as required.

PART 2 PRODUCTS

2.1 MATERIALS

- A. The paint shall be a non-bleeding, quick-drying, alkyd petroleum base paint suitable for traffic-bearing surface and shall meet FS 7TP-85E and mixed in accordance with manufacture's instructions before application.

PART 3 EXECUTION

3.1 PREPARATION

- A. Sweep and clean surface to eliminate loose material and dust.
- B. Where existing pavement markings are indicated on the drawings to be removed or would interfere with the adhesion of new paint, a motorized abrasive device shall be used to remove the markings. The equipment employed shall not damage the existing paving or create a surface hazardous to vehicle or pedestrian traffic. In all areas within public rights-of-way, the method of marking removal shall be approved by governing authority.

3.2 APPLICATION

- A. Apply two (2) coats of paint at manufacturer recommended rate without the addition of thinner, with a maximum of 100 square feet per gallon. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use a straightedge to ensure a uniform, clean, and straight stripe.
- B. The following items shall be painted with the colors noted below:
 - 1. Pedestrian Crosswalks: Yellow
 - 2. Exterior Sidewalk Curbs, Light Pole Bases and Guardposts: Yellow
 - 3. Fire Lanes: Red or per local code
 - 4. Lane Striping where separating traffic in opposite directions: Yellow
 - 5. Lane Striping where separating traffic in the same direction: White
 - 6. Handicap Symbols: per local code
 - 7. Parking Stall Striping: plans Yellow, unless otherwise noted

END OF SECTION # 32 17 23

SECTION 32 31 14 - PVC COATED CHAIN LINK FENCE AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. PVC-coated chain link fencing, gates, and accessories.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate materials, dimensions, details, and finish, show locations and installation procedures. Include details of fence and gate joints, attachments, accessories, footings, and clearances.
- B. Product Data: Submit manufacturer's schedules, charts, literature, and illustrations indicating the performance, fabrication procedures, product variations and accessories indicating material compliance and specified options.
- C. Samples: Submit color selection of PVC finishes for Architect's selection. If requested, submit samples of materials (i.e., fabric, wires, and accessories).

1.4 QUALITY ASSURANCE

- A. Chain link fabric shall have the PVC thermally fused to the galvanized steel core wire. Extruded or bonded and glued chain link fence fabric will not be accepted.
- B. Fence framework shall have the PVC thermally fused in compliance with ASTM F1043.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specifications are based on products of Anchor Fence, Inc., Baltimore, MD, Phone (410) 633-6500, Fax (410) 633-6506.
- B. Other manufacturers must have a minimum of five (5) years experience manufacturing chain link fencing and gates meeting or exceeding the following specifications for design, size, gauge, finish of metal parts and fabrication and comply with Division 1 requirements for substitutions in order to be considered.
 - 1. American Fence and Supply Co.; League City, TX (281) 332-0511
 - 2. Merchants Metals, Houston, TX; (800) 254-0080

2.2 CHAIN LINK FENCE MATERIALS

- A. Fence Fabric:
 - 1. PVC coating thermally fused to zinc-coated or zinc-5 percent aluminum-mischmetal alloy-coated steel core wire: ASTM F668 Class 2b, 7 mil thickness thermally fused. Core wire tensile strength 75,000 psi.

2. Size: Helically wound and woven to height of six (6) feet with two (2) inch diamond mesh, with core wire diameter of 0.148 inch (9 gauge) and a breakload of 1290 lbf . Color shall comply with ASTM F934 as selected by Architect from manufacturer's available colors.
 3. Selvage of fabric shall be knuckled at top and knuckled at bottom.
- B. Fence Framing:
1. Steel pipe - Type I: ASTM F1083, standard weight schedule 40; minimum yield strength of 25,000 psi; sizes as indicated below. Hot-dipped galvanized with minimum average 1.8 oz/ft² of coated surface area.
 - a. Line posts: 1.90 inch o.d. up to 6 feet on center; 2.375 inch o.d. up to 10 feet on center.
 - b. Terminal, End, Corner, and Pull posts: 2.375 inch o.d. up to 6 feet on center; 2.975 inch o.d. up to 10 feet on center
 - c. Rails and Braces: 1.660 inch o.d.
 2. PVC finish: In accordance with ASTM F1043, apply supplemental color coating of 10 to 15 mils thermally fused PVC in green.
- C. Fence Accessories:
1. Chain link fence accessories: Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing.
 2. Post caps: Formed steel, cast malleable iron, or aluminum alloy weathertight closure cap for tubular posts. Provide one cap for each post. (Where top rail is used, provide tops to permit passage of top rail.)
 3. Top rail and brace rail ends: Formed steel, malleable or cast iron, for connection of rail and brace to terminal posts.
 4. Top rail sleeves: 6 inch sleeve allowing for expansion and contraction of top rail.
 5. Wire ties: 9 gauge galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge for rails and braces. Hog ring ties of 12-1/2 gauge for attachment of fabric to tension wire.
 6. Brace and tension (stretcher bar) bands: Pressed steel.
 7. Tension (stretcher) bars: One piece lengths equal to 2 inches less than full height of fabric with a minimum cross-section of 3/16 inch x 3/4 inch or equivalent fiber glass rod. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
 8. Tension wire: Thermally fused vinyl applied to metallic coated steel wire, 7 gauge, diameter core wire with tensile strength of 75,000 psi.
 9. Truss rods: Steel rods with minimum diameter of 5/16 inch.
 10. Nuts and bolts are galvanized but not vinyl coated. Color coat nuts and bolts with PVC touch up paint, provided by manufacturer, to match adjacent finishes.

2.3 CHAIN LINK SWING GATES (Manual)

- A. Gate frames: Fabricate chain link swing gates in accordance with ASTM F900 using galvanized steel tubular members, 2 inches square, weighing 2.60 lb/ft. Fusion or stainless steel welded connections forming rigid one-piece unit. Vinyl coated frames thermally fused with 10 to 15 mils of PVC in accordance with ASTM 1043. PVC color to match fence.
- B. Chain link fence fabric: PVC thermally fused to metallic coated steel wire, ASTM F668, Class 2b, in color, mesh, and gauge to match fence. Install fabric with hook bolts and tension bars at all four (4) sides. Attach to gate frame at not more than 15 inches on center.
- C. Hardware materials: Hot dipped galvanized steel or malleable iron shapes to suit gate size. Field coat moveable parts (i.e. hinges, latch, keeper, and drop bar) with PVC touch up paint, provided by manufacturer, to match adjacent finishes.

- D. Hinges: Structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180 degrees inward.
- E. Latch: Forked type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.
- F. Keeper: Provide keeper for each gate leaf over five (5) feet wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
- G. Double gates: Provide drop rod to hold inactive leaf. Provide gate stop pipe to engage center drop rod. Provide locking device and padlock eyes as an integral part of latch, requiring one (1) padlock for locking both gate leaves.
- H. Gate posts: Steel pipe, ASTM F1083, standard weight schedule 40; minimum yield strength of 25,000 psi, 2.875 inches in diameter. Hot-dipped galvanized with minimum 1.8 oz/ft² of zinc or respective material finished in accordance with ASTM F1043. PVC color to match fence

2.4 CHAIN LINK CANTILEVER SLIDE GATES

- A. Gate frames: Fabricate chain link cantilever slide gates in accordance with ASTM F1184, Type II, Class 2, using two (2) inch square aluminum members, ASTM B221, alloy and temper 6063-T6, weighing 0.94 lb/ft. Weld members together forming rigid one-piece frame integral with top track. (no substitution) Frame members to be square, straight and true to within 1mm over a 40 feet span in an un-stressed state. Provide two (2) truck assemblies for each gate leaf, except as indicated for gates larger than 30 feet. Frame sizes over 27 feet in length shall be shipped in two (2) parts and field spliced with special attachments provided by the manufacturer.

Gate Leaf Sizes

Cantilever Support (Overhang)

| | |
|--------------------|------------------|
| 6 feet to 10 feet | 6 feet-6 inches |
| 11 feet to 14 feet | 7 feet-6 inches |
| 15 feet to 22 feet | 10 feet-0 inches |

For gate leaf size 23 feet to 30 feet, weld an additional two (2) square lateral support rail adjacent to top horizontal rail. Bottom rail shall consist of 2 inch x 4 inch aluminum member weighing 1.71 lb/ft.

Gate Leaf Sizes

Cantilever Support (Overhang)

| | |
|--------------------|------------------|
| 23 feet to 30 feet | 12 feet-0 inches |
|--------------------|------------------|

For gate leaf sizes 31 feet to 40 feet, weld two (2) top track/rails together forming a dual enclosed track. Provide two (2) truck assemblies for each track for each gate leaf, total 4 truck assemblies. Bottom rail shall consist of 2 inch x 4 inch aluminum member weighing 1.71 lb/ft.

Gate leaf sizes

Cantilever Support (Overhang)

| | |
|--------------------|------------------|
| 31 feet to 35 feet | 13 feet-6 inches |
| 36 feet to 40 feet | 16 feet-0 inches |

For gate leaf sizes 41feet to 50 feet, fabricate 24 inch wide rigid box frame truss. Truss shall consist of dual side frames, constructed similar to standard single leaf gates, separated by square cross members and diagonal truss rod bridging. Dual side frames shall each contain top track/rail

to provide support for truss from both sides. Provide four (4) trucks for each track, total eight (8) for each gate leaf. Weld steel plate between top of support posts to maintain truck assemblies in alignment with tracks.

Gate Leaf Sizes

41 feet to 50 feet

Cantilever Support (Overhang)

Custom engineered by manufacturer

- A. Finish:
 - 1. Gate Frame Finish: Natural Aluminum
 - 2. Chain Link Filler Finish: Aluminized - ASTM A491
- B. Chain Link Mesh (Fabric):
 - 1. Hot dipped galvanized after weaving with a minimum zinc coating weight per ASTM A392, Class I with weight of zinc coating not less than 1.2 oz/ft² of uncoated wire surface.
 - 2. Size: Helically wound and woven to height of six (6) feet with two (2) inch diamond mesh, with core wire diameter of 0.148 inch (9 gauge) and a breakload of 1,290 lbf.
- C. Bracing: Provide diagonal adjustable length truss rods of 3/8 inch galvanized steel, in each panel of gate frames.
- D. Top track/rail: Enclosed combination one-piece track and rail, aluminum extrusion with weight of 3.72 lb/ft. Track to withstand reaction load of 2,000#.
- E. Truck assembly: Swivel type, zinc die cast, with 4 sealed lubricant ballbearing rollers, two (2) inches in diameter by 9/16 inch in width, and two (2) side rolling wheels to ensure truck alignment in track. (no substitution) Mount trucks on post brackets using 7/8 inch diameter ball bolts with 1/2 inch shank. Truck assembly to withstand same reaction load as track, 2,000#.
- F. Gate hangers, latches, brackets, guide assemblies, and stops: Malleable iron or steel, galvanized after fabrication. Provide positive latch with provisions for padlocking.
- G. Bottom guide wheel assemblies: Each assembly shall consist of two, 3 inch diameter rubber wheels, straddling bottom horizontal gate rail, allowing adjustment to maintain gate frame plumb and in proper alignment. Attach one assembly to each guide post.
- H. Gates posts:
 - 1. For gates under 31 feet: galvanized steel four (4) inch OD schedule 40 pipe, ASTM F1083, weighing 9.1 lb/ft. Provide one (1) latch post and two (2) support posts for single slide gates and four (4) support posts for double slide gates.
 - 2. For gates 31 feet-0 inches or larger; two (2) pairs of support posts for each leaf (dual) four (4) inch OD schedule 40 pipe, ASTM F1083, weighing 9.1 lb/ft each. Posts connected by welding six (6) inch x 3/8 inch plate between posts. Also one (1) 4 inch latch post.
 - 3. Gate post finish shall match fence mesh.

2.5 SETTING MATERIALS

- A. Concrete: Minimum 28 day compressive strength of 3,000 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.

- B. Ensure property lines and legal boundaries of work are clearly established.

3.2 CHAIN LINK FENCE FRAMING INSTALLATION

- A. Install chain link fence in accordance with ASTM F567 and manufacturer's instructions.
- B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30 degrees or more.
- C. Space line posts uniformly at 10 feet on center.
- D. Concrete fence post footings:
 - 1. Drill holes in firm, undisturbed or compacted soil. Excavate deeper than specified below as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
 - 2. Line posts shall be set in 9 inch minimum diameter concrete piers, with a minimum of 33 inches of post embedment in concrete with an additional 3 inch concrete cover at bottom.
 - 3. All end, corner, and pull posts shall be set in minimum 12 inch minimum diameter concrete piers, with a minimum of 33 inches of post embedment in concrete with an additional 3 inch concrete cover at bottom.
 - 4. Place concrete around posts in a continuous pour.
 - 5. Trowel finish around post. Slope to direct water away from posts.
- E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.
- F. Bracing: Install horizontal pipe brace at mid-height for fences six (6) and over, on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.
- G. Tension wire: Provide tension wire at bottom of fabric. Install tension wire before stretching fabric and attach to each post with ties. Secure tension wire to fabric with 12-1/2 gauge hog rings 24 inches on center.
- H. Top rail: Install lengths, 21 feet. Connect joints with sleeves for rigid connections for expansion/contraction.

3.3 CHAIN LINK FABRIC INSTALLATION

- A. Fabric: Install fabric on security side and attach so that fabric remains in tension after pulling force is released. Leave approximately 2 inches between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15 inches on center and to rails, braces, and tension wire at 24 inches on center.
- B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15 inches on center.

3.4 ACCESSORIES

- A. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.
- B. Fasteners: Install nuts on side of fence opposite fabric side for added security.

3.5 CHAIN LINK SWING GATE POST INSTALLATION

- A. Install gate posts in accordance with manufacturer's instructions.
- B. Concrete gate post footings:
 - 1. Drill holes in firm, undisturbed or compacted soil. Excavate deeper than specified below as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
 - 2. All gate posts shall be set in minimum 12 inch minimum diameter concrete piers, with a minimum of 33 inches of post embedment in concrete with an additional 3 inch concrete cover at bottom.
 - 3. Place concrete around posts in a continuous pour.
 - 4. Trowel finish around post. Slope to direct water away from posts.
- C. Gate posts and hardware: Set keeper, stops, sleeves into concrete. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

3.6 CHAIN LINK SWINGGATE INSTALLATION

- A. Install gates plumb, level, and secure for full opening without interference.
- B. Attach hardware by means which will prevent unauthorized removal.
- C. Adjust hardware for smooth operation.
- D. Touch up hardware with PVC touch up paint, provided by manufacturer, to match adjacent finishes.

3.7 CHAIN LINK CANTILEVER SLIDE GATE POST INSTALLATION

- A. Install gate posts in accordance with manufacturer's instructions.
- B. Drill holes in firm, undisturbed or compacted soil.
- C. Holes shall have diameter four (4) times greater than outside dimension of post, and depths approximately six (6) inches deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
- D. Set post bottom 36 inches below surface when in firm, undisturbed soil.
- E. Place concrete around posts in a continuous pour, tamp for consolidation.
- F. Trowel finish around post and slope to direct water away from posts.
- G. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

3.8 CHAIN LINK CANTILEVER SLIDE GATE FRAME INSTALLATION

- A. Install gate frames on posts in accordance with manufacturer's instructions.

3.9 CLEANING

- A. Clean up debris and unused material, and remove from the site.
- B. Adjust gates for smooth, noiseless operation.

END OF SECTION 32 31 14

SECTION 328400 IRRIGATION

PART 1 – PRODUCTS

1.1 GENERAL

Unless otherwise noted on the Drawings, all materials shall be new and unused. The irrigation equipment catalog numbers used for reference in these Specifications are to establish minimum quality standards and may be substituted with an "approved equal" as outlined in Paragraph 1.06 of this section, unless specifically requested by the Owner.

1.2 POLYVINYL CHLORIDE PIPE (PVC PIPE)

PVC pipe manufactured in accordance with ASTM Standards noted herein.

- A. Marking and Identification: PVC pipe shall be continuously and permanently marked with the following information: Manufacturer's name, size, type of pipe, and material, PVC number, Product Standard number, and the NSF (National Sanitation Foundation) Seal.
- B. PVC pipe fittings: Shall be of the same material as the PVC pipe specified and compatible with PVC pipe furnished. Solvent weld type shall be for Schedule 40.
- C. PVC Pipe: Lateral line pipe shall be Class 200 solvent weld, SDR-21, PS 22-70 for all sizes 3/4" - 2". Mainline pipe shall schd.40 PVC, unless otherwise noted on the Drawings.
- D. Flexible PVC Risers (Nipples): All flexible PVC nipples shall be made from virgin PVC material, and shall comply with ASTM D2287, shall be tested at 200 P.S.I. static pressure for 2 hours and have a quick burst rating of a minimum 400 P.S.I. Flexible PVC pipe nipples shall be factory assembled only.
- E. Unless otherwise noted on the Drawings, no pipe smaller than 3/4" shall be used.

1.3 SWING JOINTS

Swing joints shall be O-ring seal type. Use Lasco, KBI or approved equal.

1.4 WIRE AND SPLICES

- A. All electrical, control and ground wire shall be of size as indicated on the Drawings or in these Specifications. All wiring to be used for connecting the automatic remote control valve to the automatic controllers shall be Type "UF" 600 volt, solid copper, single conductor wire with PVC insulation and bear UL approval for direct underground burial feeder cable.
- B. Verification of wire types and installation procedures shall be checked to conform to local codes.
- C. Wire connectors shall be King low voltage connectors, tan color.
- D. No. 14 UF Direct Burial Cable
 - 1. Conductor: Soft-annealed copper conforming to UL std. 719, Parts 18-22.
 - 2. Insulation: Polyvinylchloride, 60 degree C rated, conforming to UL std. 719, Parts 23-25.
 - 3. Manufacturer's Identification: Surface embossed with manufacturer's name, voltage rating, size and type of designation.
 - 4. Underwriter's Laboratories Approval: All cable shall be tested physically and electrically in accordance with UL std. 719, and shall bear UL labels.
- E. No. 10/2 UF Direct Burial Cable:
 - 1. Conductors: The conductors shall consist of solid, soft-annealed copper.
 - 2. Insulation: Over each conductor, there shall be extruded a polyvinylchloride compound, UL rated for 60 degrees CENTIGRADE.

3. Color Coding: In conformance with the National Electrical Code.
4. Assembly: Flat, parallel configuration.
5. Overall Sheath: A polyvinylchloride sheath compound conforming to UL 719, for "UF" cable shall be applied overall.

F. Ground: The ground conductor shall consist of solid, uncoated soft-annealed No. 6 copper wire.

1.5 MANUAL/ISOLATION VALVES

- A. All isolation valves 2-1/2 inches and larger shall be resilient wedge gate valve as manufactured by Matco-Norca series 10RT. All isolation valves smaller than 2-1/2" shall be Speers PVC, double union ball valves or approved equal. All valves must be certified for a working pressure of 125 PSI with a hydrostatic shell test of 200 PSI and a hydrostatic seal test of 150 PSI. Both ends must be screw type for use with PVC pipe.
- B. All isolation valves shall be housed in an appropriately sized valve box.

1.6 ELECTRIC REMOTE CONTROL VALVES

- A. All electric valves shall be "normally closed", solenoid operated, 24 volt A.C., 60 Hz., Globe- Angle or Globe type valve installed in the angle or globe configuration.
- B. Valves shall be Hunter, Pressure Regulating (XPR), Series, unless otherwise indicated on the Drawings.
- C. A flow stem adjustment shall be included in each valve.

1.7 VALVE BOXES – ARMOR

- A. All electrical valves shall be placed below grade within 10" round valve boxes. Valve boxes shall be Armor Model No. 181104 with matching green bolt down or locking cover marked "Irrigation Control Valve," or approved equal.
- B. All isolation shut-off valves shall be installed in suitable valve access boxes or proper size as required for easy access to the valve. Valve boxes shall be Armor Model No. 181104 (minimum size), with matching green bolt down or locking cover marked "Irrigation Control Valve," or approved equal.
- C. A valve box shall be provided for all valves.
- D. Boxes shall be suitable in size and configuration for the operability and adjustment of the valve.
- E. Extension sections will be used as appropriate to the depth of piping.
- F. All valve box covers shall bolt down or have locking mechanisms and shall be colored green.

1.8 POP-UP SPRAY, MICRO SPRAY, ROTOR AND BUBBLER HEADS

- A. Pop-up spray, rotor and bubbler heads are specified on the Drawings.
- B. One adjustable bubbler head shall be provided per each tree location as shown on the Drawings.
- C. Spray heads shall have a minimum 4" pop-up or 12" pop-up as designated on the Drawings. The sprinkler body and all related parts shall be plastic cyclac or polycarbonate. They shall have a spring retraction for positive return action of the pop-up nozzle. The spring for retraction and the adjustable nozzle screw shall be made of corrosion resistant materials.
- D. All heads are to be operated and site adjusted to match precipitation rate of all heads in the zone with proper nozzle selection and arc adjustments.
- E. MICRO-SPRAYS -The nozzle shall be constructed of corrosion and UV-resistant plastic. The nozzle shall have a pop-up stem that when under water pressure, pops up an additional inch. It shall also have a stainless steel retraction spring to retract the stem when water pressure is

released. The stem shall have an integral elastomeric flow bushing for maintaining a constant flow rate over the operating pressure range of 25 to 60 PSI (1.7 to 4.1 bars; 172 to 413 kPa). The nozzle shall be protected from debris by a stainless steel screen that is integral to the pop-up stem. The nozzle shall have standard female threads that are compatible with the threaded riser on Hunter spray heads as well as some other manufacturer's spray heads. The nozzle shall carry a two-year, exchange warranty (not prorated). Must be installed in Institutional spray body.

1.9 DRIP IRRIGATION

- A. The dripperline shall be Techline CV as manufactured by Netafim Irrigation, Inc. Dripper flow rate and spacing shall be as indicated on the Drawings.
- B. Soil Staples (TLS6): All on-surface/under mulch Techline CV/Techline Techlite installations shall be held in place with Techline Soil Staples spaced evenly every 3' to 5' on center, and with two staples on each change of direction.
- C. Line Flushing Valves: All Techline/Techlite systems shall be installed with Netafim Automatic Line Flushing Valves as indicated on drawings. Techline CV zones do not require an automatic line flushing valve but must have a manual flushing port(s) in the position that an automatic flush valve would be positioned.
- D. Pressure Regulator: A pressure regulator shall be installed at each zone valve or on the main line to ensure operating pressures do not exceed system requirements. The pressure regulator shall be a Netafim Pressure Regulator.
- E. Disc Filter: A disc filter shall be installed at each zone valve or on the main line to ensure proper filtration. The filter shall be a Netafim Disc Filter. Model number and mesh as indicated on the Drawings.

1.10 ELECTRIC CONTROLLER

- A. The electric irrigation controller shall be an MIR-5000 type controller capable of operating the number of stations as indicated on the Drawings. The system is designed to operate multiple valves at a time, unless otherwise noted. The controller will be specified on the Drawings.
- B. Power source shall be standard 120 volt 60 Cycle AC. Output for operation of companion solenoid actuated valves shall be 24 volts 60 Cycle AC., unless otherwise noted on the Drawings.
- C. Provide an automatic rain/freezing shutoff with controller.
- D. All local and applicable codes shall take precedence in the furnishing and/or connecting of the 120 volt electrical service to the controller.
- E. Adequate coverage and protect of the 24 volt service wires leading from the controllers shall be installed from the bottom of the controllers to at least six (6) inches below ground level or to floor level.

1.11 BACKFLOW PREVENTER

- A. A backflow prevention device shall be located and sized as shown on the Drawings.
- B. This assembly shall be installed in a box and conform to the City Plumbing Codes and manufacturer's recommendations.
- C. Backflow preventer housing shall be called for on the Drawings.

1.12 GLUE

- A. All glue used shall be Red Christie Hot Glue.

PART 2 - EXECUTION

2.1 INSTALLATION, GENERAL

- B. Design Pressure: This irrigation system has been designed to operate with a minimum static inlet water pressure as indicated on the Drawings. The Contractor shall take a pressure reading prior to beginning construction. If the pressure reading is 5% less than above, the Contractor shall notify the Landscape Architect.
- C. Contractor Responsibility: The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in equipment usage, area dimensions or water pressure exist that might not have been considered in the design. Any deviation between the Contract Documents and field conditions shall be brought to the attention of the Landscape Architect in writing. In the event this notification is not performed, the Contractor shall assume full responsibility for any revision necessary.
- D. Staking: Before installation is started, place a stake or flag where each sprinkler is to be located, in accordance with the Drawings. Staking shall be approved by the Landscape Architect before proceeding.
- E. Piping Layout: Piping layout is diagrammatic. Route piping around existing trees and root zones in such a manner as to avoid damage to plantings. Where access is restricted, bore under large existing trees to avoid damage and exposure of the root system. Do not dig within the ball of newly planted trees or shrubs.
- F. In areas where trees are present, trenches will be adjusted on site to provide a minimum clearance of four times the trunk diameter of the tree (at its base) between any tree and any trench.
- G. All material and equipment shall be delivered to the Worksite in unbroken reels, cartons or other packaging to demonstrate that such material is new and of a quality and grade in keeping with the intent of these Specifications.
- H. Refer to the Drawings for drip installation details.

2.2 EXCAVATION AND TRENCHING

- A. All backfill operations shall conform to Title 30, TAC, Chapter 344.62, effective Jan. 1, 2009.
- B. The Contractor shall perform all excavation to the depth indicated in these Specifications and Contract drawings. The banks of trenches shall be kept as nearly vertical as practicable. Trenches shall be wide enough to allow a minimum of 4" between parallel pipelines or electrical wiring. Where rock excavation is required, or where stones or rubbles is encountered in the bottom of the trench that would create a concentrated pressure on the pipe, the rock, stones, or rubble shall be removed to a depth of six (6) inches minimum below the trench depth indicated. The over depth rock excavation and all excess trench excavation shall be backfilled with loose, moist earth or sand, thoroughly tamped. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the trench bottom, such shall be removed to a depth and length required, and the trench backfilled to trench bottom grade as hereinafter specified, with course sand, fine gravel or other suitable material.
- C. Bottom of trench grade shall be continued past ground surface deviations to avoid air pockets and low collection points in the line. The minimum cover specifications shall govern regardless of variations in ground surface profile and the occasional deeper excavation required at banks and other field conditions. Excavation shall be such that a uniform trench grade variation will occur in all cases where variations are necessary.
- D. Trench excavation shall comprise the satisfactory removal and disposition of all materials, and shall include all shoring and sheeting required to protect the excavation and to safeguard employees.

- E. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance back from edge of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted as directed by the Landscape Architect. When excavated material is of a rocky nature and the topsoil or any other layer of excavated material is suitable for pipe bedding and backfill in the vicinity of the pipe, such material shall be separately stockpiled for use in such bedding and pipe backfill operations, unless satisfactory imported material is used.
- F. All excavations and backfill shall be unclassified and covered in the basic bid. No additional compensation will be allowed for rock or rubble encountered.
- G. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations to their original conditions in a manner acceptable to the Landscape Architect.

2.3 PIPE INSTALLATION

- A. Sprinkler Mains: Sprinkler mains are that portion of piping from water source to electric valves. This portion of piping is subject to surges since it is a closed portion of the sprinkler system. Sprinkler mains shall be installed in a trench with a minimum of 18 inches of cover.
- B. Lateral Piping: Lateral piping is that portion of piping from electrical valve to sprinkler heads. This portion of piping is not subject to surges since it is an "open end" portion of the sprinkler system. Lateral piping shall be installed in a trench with a minimum of 18 inches of cover.
- C. Remove lumber, rubbish, and rocks from trenches. Provide firm, uniform bearing for entire length of each pipeline to prevent uneven settlement. Wedging or blocking of pipe will not be permitted. Remove foreign matter or dirt from inside of pipe before welding, and keep piping clean during and after laying pipe.
- D. PVC pipe shall not be installed where there is water in the trench, nor shall PVC pipe be laid when temperature is 40 deg. F or below or when rain is imminent. PVC pipe will expand and contract as the temperature changes. Therefore, pipe shall be snaked from side to side of trench bottom to allow for expansion and contraction.
- E. PVC pipe shall be cut with a hand saw or hack saw with the assistance of a square and sawing vice, or in a manner so as to ensure a square cut. Burrs at cut ends shall be removed prior to installation so that a smooth unobstructed flow will be obtained.
- F. All PVC pipe shall be installed with pipe markings facing the top of the trench.
- G. Thrust blocks shall be installed as indicated on the Drawings.

2.4 PVC PIPE AND FITTING ASSEMBLY

- A. Make solvent-welded joints following standards noted herein. Thoroughly clean pipe and fittings of dirt, dust, and moisture with an approved colored PVC primer before applying solvent.
- B. All plastic to plastic joints shall be solvent-weld joints or slip seal joints. Only the solvent recommended by the pipe manufacturer shall be used. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the Contractor's responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The Contractor shall assume full responsibility for the correct installation.
- C. Solvent weld joints shall be made in the following manner:
 - 1. Thoroughly clean the mating pipe and fittings with approved cleaner and a clean dry cloth.
 - 2. Apply a uniform coat of solvent to the outside of the pipe with a non-synthetic bristle brush or applicator.
 - 3. Apply solvent to inside of the fitting in a similar manner.
 - 4. Re-apply a light coat of solvent to the pipe and quickly insert it into the fitting.

5. Give the pipe or fitting a quarter turn to ensure even distribution of the solvent and make sure that the pipe is inserted to the full depth of the fitting socket.
 6. Hold in position for 15 seconds.
 7. Wipe of excess solvent that appears at the outer shoulder of the fitting. Cure 24 hours before charging system with water.
- D. PVC to Metal Connection: Work metal connections first. Use a non-hardening pipe dope such as Permatex No. 2 or "Teflon" tape on threaded PVC to metal joints. Use only light wrench pressure. All plastic to metal joints shall be made with plastic male adapters.
- E. Threaded PVC Connections: Where required, use threaded PVC adapters into which pipe may be welded.

2.5 CONTROL WIRE INSTALLATION

- A. All electric control cables shall be of size as shown on the Drawings and/or as specified and shall be installed in the piping trenches wherever possible.
- B. Install wire in the pipe trench as detailed on the Drawings.
- C. Wire shall be placed in the trench as loose as possible and with as much slack as possible to allow for expansion and contraction of the wire. Where it is necessary to run wire in a separate trench, the wire shall have at least twelve (12) inches of cover.
- D. All wire connections at remote control valves, either direct buried or in boxes, and at all splices shall be left with sufficient slack so that in case of repair, the splice may be brought to the surface without disconnecting the wires. Slack shall be coiled in approximately 1" wraps.
- E. Each remote control valve or group of remote control valves, which are to be connected to one station of a controller, shall have wire sizes as shown in the wiring diagrams on the Drawings or as specified. All remote control valves, what are to be connected to the same controller, shall be connected to a common ground wire system entirely independent of the common ground wire system of all other controllers. Only those remote control valves which are being controlled by one specific controller, shall be connected to that controller's common ground wire system.
- F. All control wire less than 500 feet in length shall be continuous without splices or joints from the controller to the valves. Connections to the electric valves shall be made within 18 inches of the valve using connectors specified in Paragraph 2.4 of this section, unless otherwise approved by the Landscape Architect in writing.
- G. The Contractor shall obtain the Landscape Architect's approval for wire routing when installed in a separate ditch. Control wires may be installed in a common ditch with piping; however, wires must be installed underneath mainline piping.
- H. All wire passing under existing or future paving, sidewalk, construction, etc., shall be encased in 1" minimum PVC Schedule 40 conduit extending at least twelve (12) inches beyond edges of paving, sidewalks, or construction.

2.6 POP-UP SPRAY, MICRO-SPRAY, ROTORY AND BUBBLER HEADS

- A. Provide heads and nozzles as specified and install in locations as shown on the Contract Drawings.
- B. All heads of a particular type and for a particular function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification, in such a position that they can be identified without being removed from the system. All sprinkler heads and quick coupling valves shall be set perpendicular to finished grades unless otherwise indicated on the Drawings.
- C. Pop-up spray and micro-spray heads shall be installed on a swing joint pipe connector as detailed. Rotary heads shall be installed on a double swing joint connected to the lateral pipe. Bubbler shall be a tree well flexible riser-bubbler head on a flex pipe. Provide wire staple to

secure the bubbler to the top of the root ball. Keep heads a minimum of 4 inches from paved surfaces.

- D. Heads shall be installed with underside of flange flush with the finished grade.
- E. Contractor will be required to adjust heads as necessary after establishment of grass or other plant material.

2.7 MANUAL VALVES

- A. Manual valves shall be sized and located where shown on the Drawings.
- B. Valve boxes shall be adjusted to be flush with finished grade.
- C. Valve boxes shall be properly supported and of sufficient construction that tractors, mowers or other equipment crossing over the boxes will not push boxes down and damage the pipe, valve, or box.

2.8 VALVE AND VALVE BOX PLACEMENT

- A. A ball valve shall precede each valve to provide shut off for repair of valves.
- B. All manual, electric, and quick coupling valves shall be in boxes as specified in Paragraph 2.6 of this section, and shall be set with a minimum of six (6) inches of space between their top surface and the bottom of the valve box. The base of the box shall be filled with pea gravel per manufacturer's installation instructions.
- C. Valves shall be fully opened and fully closed to ensure that all parts are in operating condition.
- D. Valve boxes shall be set plumb, vertical, and concentric with the valve stem.
- E. Any valve box which has moved from this required position so as to prevent the use of the operating wheel of the valve shall be reset by the Contractor at his own expense.

2.9 ELECTRIC CONTROLLER

- A. Electric controller shall be located as shown on the Drawings and shall be capable of operating the number of stations indicated.
- B. The system is designed to operate multiple sections at a time, unless otherwise noted on the Drawings in strict accordance with the manufacturer's published installation instructions.

2.10 ELECTRIC REMOTE CONTROL VALVES

- A. Remote control valves shall be located and sized as shown on the Drawings. All electrical connections shall be made when the weather is dry with connection kits as specified in Paragraph 2.4 of this section in strict accordance with manufacturer's recommended procedures. All remote control valves shall be installed in a horizontal position, in accordance to the manufacturer's published installation instructions.
- B. It shall be the responsibility of the Contractor to furnish and install the proper size wire on each of the low voltage circuits from the master control center to the various electric remote control valves.
- C. Consideration shall be given to each circuit for allowance of voltage drop and economy consistent with accepted practices of electrical installation. Under no circumstances shall the voltage of any branch circuit be reduced more than proper due to length of run exceeding the maximum allowable for the wire size used. "Up-sizing" wire to compensate for voltage drop shall be at the Contractor's expense, whether or not indicated on the Drawings.

2.11 BACKFILL AND COMPACTION

- A. After system is operating and required tests and inspections have been made, the trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, gravel, soft shale, or other approved materials, free from large clods of earth or stone. Rock, broken concrete, or pavement, and large boulders shall not be

used as backfill material. The backfill shall be thoroughly compacted and made flush with the adjacent soil level.

- B. Compact trenches in areas to be planted by thoroughly flooding the backfill with water. Compact all other areas by flooding or hand tamping. The jetting process may be used in areas when flooding.
- C. Backfill for all trenches, regardless of the type of pipe covered, shall be compacted to a minimum of 90% density.
- D. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for compaction, then refilled and compacted with the surface restored to the required grade and left in a completed surface condition as described above.
- E. Specifically tamp backfill under heads and around the flange of heads in a one (1) foot radius by a suitable means after trench backfill has dried from flooding to prevent heads loosening in the ground.

2.12 FINAL ADJUSTMENT

- A. After installation has been completed, make final adjustment of sprinkler system prior to Landscape Architect's final inspection.
- B. Completely flush system to remove debris from lines by removing nozzle from heads on ends of lines and turning on system.
- C. Check sprinklers for proper operation and proper alignment for direction of throw.
- D. Check each new section for operating pressure and balance to other sections by use of flow adjustment on top of each valve.
- E. Check nozzling for proper coverage. Prevailing wind conditions may indicate that arc or angle of spray should be other than as shown on the Drawings. In this case, change nozzles to provide correct coverage and furnish as-built data to Landscape Architect with each change.
- F. After system is thoroughly flushed and ready for operation, each section of sprinklers shall be adjusted to control pressure at heads. Use the following method, one section at a time:
 - 1. Remove last head on section and install a temporary riser above grade. Install tee with pressure gauge attached on top of riser and re-install head with nipple onto tee.
 - 2. Correct operating pressure at last head of each section as follows: Spray Heads - 20-25 psi; rotor heads - 30 to 40 psi (and as recommended by the manufacturer).
 - 3. After replacing head, at grade, tamp thoroughly around head.
- G. Prior to final inspection, cycle the system through three (3) complete watering schedules of not less than twenty (20) minutes each for sprinklers and three (3) hours each for drip to assure proper function of sprinklers, valves and controller.

2.13 CLEAN-UP

- A. The Site shall be thoroughly cleaned of all waste materials and all unused or salvaged materials, equipment, tools, etc.
- B. After completion of the work, areas disturbed shall be leveled and the Site shall be raked clean and left in an orderly condition.

2.14 TEMPORARY IRRIGATION FOR GRASS ESTABLISHMENT

If the permanent irrigation system is inoperable the Contractor shall provide temporary irrigation for all new turf areas. Temporary irrigation may include equipment securely staked above grade. It shall be the Contractor's responsibility to provide complete, consistent temporary coverage in order to establish a viable, mowable stand of grass. Any above grade equipment shall be removed by the Contractor upon acceptance of the turf by the Landscape Architect.

END OF SECTION 328400

SECTION 328401- NON-POTABLE IRRIGATION

PART 1 – PRODUCTS

1.12 GENERAL

Unless otherwise noted on the Drawings, all materials shall be new and unused. The irrigation equipment catalog numbers used for reference in these Specifications are to establish minimum quality standards and may be substituted with an "approved equal" as outlined in Paragraph 1.06 of this section, unless specifically requested by the Owner.

1.13 POLYVINYL CHLORIDE PIPE (PURPLE PVC PIPE)

PVC pipe manufactured in accordance with ASTM Standards noted herein.

- A. Marking and Identification: PVC pipe shall be continuously and permanently marked with the following information: Manufacturer's name, size, type of pipe, and material, PVC number, Product Standard number, and the NSF (National Sanitation Foundation) Seal.
- B. PVC pipe fittings: Shall be of the same material as the PVC pipe specified and compatible with PVC pipe furnished. Solvent weld type shall be for Schedule 40.
- C. PVC Pipe: Lateral line pipe shall be Class 200 solvent weld, SDR-21, PS 22-70 for all sizes 3/4" - 2". Mainline pipe shall schd.40 PVC, unless otherwise noted on the Drawings.
- D. Flexible PVC Risers (Nipples): All flexible PVC nipples shall be made from virgin PVC material, and shall comply with ASTM D2287, shall be tested at 200 P.S.I. static pressure for 2 hours and have a quick burst rating of a minimum 400 P.S.I. Flexible PVC pipe nipples shall be factory assembled only.
- E. Unless otherwise noted on the Drawings, no pipe smaller than 3/4" shall be used.

1.14 SWING JOINTS

Swing joints shall be O-ring seal type. Use Lasco, KBI or approved equal.

1.15 WIRE AND SPLICES

- A. All electrical, control and ground wire shall be of size as indicated on the Drawings or in these Specifications. All wiring to be used for connecting the automatic remote control valve to the automatic controllers shall be Type "UF" 600 volt, solid copper, single conductor wire with PVC insulation and bear UL approval for direct underground burial feeder cable.
- B. Verification of wire types and installation procedures shall be checked to conform to local codes.

- C. Wire connectors shall be King low voltage connectors, tan color.
- D. Two-wire No. 14 UF Direct Burial Cable
 - 1. Conductor: Soft-annealed copper conforming to UL std. 719, Parts 18-22.
 - 2. Insulation: Polyvinylchloride, 60 degree C rated, conforming to UL std. 719, Parts 23-25.
 - 3. Manufacturer's Identification: Surface embossed with manufacturer's name, voltage rating, size and type of designation.
 - 4. Underwriter's Laboratories Approval: All cable shall be tested physically and electrically in accordance with UL std. 719, and shall bear UL labels.
- E. No. 10/2 UF Direct Burial Cable:
 - 1. Conductors: The conductors shall consist of solid, soft-annealed copper.
 - 2. Insulation: Over each conductor, there shall be extruded a polyvinylchloride compound, UL rated for 60 degrees CENTIGRADE.
 - 3. Color Coding: In conformance with the National Electrical Code.
 - 4. Assembly: Flat, parallel configuration.
 - 5. Overall Sheath: A polyvinylchloride sheath compound conforming to UL 719, for "UF" cable shall be applied overall.
- F. Ground: The ground conductor shall consist of solid, uncoated soft-annealed No. 6 copper wire.
- G. Ground rod, decoders, surge protectors

1.16 MANUAL/ISOLATION VALVES

- A. All isolation valves 2-1/2 inches and larger shall be resilient wedge gate valve as manufactured by Matco-Norca series 10RT. All isolation valves smaller than 2-1/2" shall be Speers PVC, double union ball valves or approved equal. All valves must be certified for a working pressure of 125 PSI with a hydrostatic shell test of 200 PSI and a hydrostatic seal test of 150 PSI. Both ends must be screw type for use with PVC pipe.
- B. All isolation valves shall be housed in an appropriately sized valve box.

1.17 ELECTRIC REMOTE CONTROL VALVES (FOR NON-POTABLE IRRIGATION)

- A. All electric valves shall be "normally closed", solenoid operated, 24 volt A.C., 60 Hz., Globe-Angle or Globe type valve installed in the angle or globe configuration.
- B. Valves shall be Hunter, Pressure Regulating (XPR), Series, unless otherwise indicated on the Drawings.
- C. A flow stem adjustment shall be included in each valve.

1.18 VALVE BOXES (FOR NON-POTABLE IRRIGATION)

- A. All electrical valves shall be placed below grade within 12X18" valve boxes. Valve boxes shall be ARMOR Series. With a purple bolt down or locking cover marked "Irrigation Control Valve," or approved equal.
- B. All isolation shut-off valves shall be installed in suitable valve access boxes or proper size (ARMOR-10RND) as required for easy access to the valve. Valve boxes shall be Rain Bird (minimum size), with matching green bolt down or locking cover marked "Irrigation Control Valve," or approved equal.
- C. A valve box shall be provided for all valves.
- D. Boxes shall be suitable in size and configuration for the operability and adjustment of the valve.
- E. Extension sections will be used as appropriate to the depth of piping.
- F. All valve box covers shall bolt down or have locking mechanisms and shall be colored green.

1.19 POP-UP SPRAY, MICRO SPRAY, ROTOR AND BUBBLER HEADS (FOR NON-POTABLE)

- A. Pop-up spray, rotor and bubbler heads are specified on the Drawings.
- B. One adjustable bubbler head shall be provided per each tree location as shown on the Drawings.
- C. Spray heads shall have a minimum 4" pop-up or 12" pop-up as designated on the Drawings. The sprinkler body and all related parts shall be plastic cycloc or polycarbonate. They shall have a spring retraction for positive return action of the pop-up nozzle. The spring for retraction and the adjustable nozzle screw shall be made of corrosion resistant materials.
- D. All heads are to be operated and site adjusted to match precipitation rate of all heads in the zone with proper nozzle selection and arc adjustments.
- E. MICRO-SPRAYS -The nozzle shall be constructed of corrosion and UV-resistant plastic. The nozzle shall have a pop-up stem that when under water pressure, pops up an additional inch. It shall also have a stainless steel retraction spring to retract the stem when water pressure is released. The stem shall have an integral elastomeric flow bushing for maintaining a constant flow rate over the operating pressure range of 25 to 60 PSI (1.7 to 4.1 bars; 172 to 413 kPa). The nozzle shall be protected from debris by a stainless steel screen that is integral to the pop-up stem. The nozzle shall have standard female threads that are compatible with the threaded riser on Hunter spray heads as well as some other manufacturer's spray heads. The nozzle shall carry a two-year, exchange warranty (not prorated). Must be installed in Institutional spray body.

1.20 DRIP IRRIGATION (FOR NON-POTABLE IRRIGATION)

- A. The dripperline shall be XFS-09-12 non-potable as manufactured by Rain Bird Irrigation, Inc. Dripper flow rate and spacing shall be as indicated on the Drawings.
- B. Soil Staples (TLS6): All on-surface/under mulch Techline CV/Techline Techlite installations shall be held in place with Techline Soil Staples spaced evenly every 3' to 5' on center, and with two staples on each change of direction.
- C. Line Flushing Valves: All Techline/Techlite systems shall be installed with Netafim Automatic Line Flushing Valves as indicated on drawings. Techline CV zones do not require an automatic line flushing valve but must have a manual flushing port(s) in the position that an automatic flush valve would be positioned.
- D. Pressure Regulator: A pressure regulator shall be installed at each zone valve or on the main line to ensure operating pressures do not exceed system requirements. The pressure regulator shall be a Netafim Pressure Regulator.
- E. Disc Filter: A disc filter shall be installed at each zone valve or on the main line to ensure proper filtration. The filter shall be a Netafim Disc Filter. Model number and mesh as indicated on the Drawings.

1.21 ELECTRIC CONTROLLER

- A. The electric irrigation controller shall be a Controller type controller capable of operating the number of stations as indicated on the Drawings. The system is designed to operate multiple valves at a time, unless otherwise noted. The controller will be specified on the Drawings.
- B. Power source shall be standard 120 volt 60 Cycle AC. Output for operation of companion solenoid actuated valves shall be 24 volts 60 Cycle AC., unless otherwise noted on the Drawings.
- C. Provide an automatic rain/freeze shutoff with controller.
- D. All local and applicable codes shall take precedence in the furnishing and/or connecting of the 120 volt electrical service to the controller.
- E. Adequate coverage and protect of the 24 volt service wires leading from the controllers shall be installed from the bottom of the controllers to at least six (6) inches below ground level or to floor level.

1.22 BACKFLOW PREVENTER (NOT FOR NON-POTABLE IRRIGATION SYSTEM)

- A. A backflow prevention device shall be located and sized as shown on the Drawings.

- B. This assembly shall be installed in a box and conform to the City Plumbing Codes and manufacturer's recommendations.
- C. Backflow preventer housing shall be called for on the Drawings.

1.23 GLUE

- A. All glue used shall be Red Christie Hot Glue.
- B. All primer shall be P-68 Purple Primer.

PART 2 – EXECUTION

2.1 INSTALLATION, GENERAL

- C. Design Pressure: This irrigation system has been designed to operate with a minimum static inlet water pressure as indicated on the Drawings. The Contractor shall take a pressure reading prior to beginning construction. If the pressure reading is 5% less than above, the Contractor shall notify the Engineer/Architect.
- D. Contractor Responsibility: The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious in the field that obstructions, grade differences or discrepancies in equipment usage, area dimensions or water pressure exist that might not have been considered in the design. Any deviation between the Contract Documents and field conditions shall be brought to the attention of the Engineer/Architect in writing. In the event this notification is not performed, the Contractor shall assume full responsibility for any revision necessary.
- E. Staking: Before installation is started, place a stake or flag where each sprinkler is to be located, in accordance with the Drawings. Staking shall be approved by the Engineer/Architect before proceeding.
- F. Piping Layout: Piping layout is diagrammatic. Route piping around existing trees and root zones in such a manner as to avoid damage to plantings. Where access is restricted, bore under large existing trees to avoid damage and exposure of the root system. Do not dig within the ball of newly planted trees or shrubs.
- G. In areas where trees are present, trenches will be adjusted on site to provide a minimum clearance of four times the trunk diameter of the tree (at its base) between any tree and any trench.
- H. All material and equipment shall be delivered to the Worksite in unbroken reels, cartons or other packaging to demonstrate that such material is new and of a quality and grade in keeping with the intent of these Specifications.
- H. Refer to the Drawings for drip installation details.

2.2 EXCAVATION AND TRENCHING

- A. All backfill operations shall conform to Title 30, TAC, Chapter 344.62, effective Jan. 1, 2009.
- B. The Contractor shall perform all excavation to the depth indicated in these Specifications and Contract drawings. The banks of trenches shall be kept as nearly vertical as practicable. Trenches shall be wide enough to allow a minimum of 4" between parallel pipelines or electrical wiring. Where rock excavation is required, or where stones or rubbles is encountered in the bottom of the trench that would create a concentrated pressure on the pipe, the rock, stones, or rubble shall be removed to a depth of six (6) inches minimum below the trench depth indicated. The over depth rock excavation and all excess trench excavation shall be backfilled with loose, moist earth or sand, thoroughly tamped. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the trench bottom, such shall be removed to a depth and length required, and the trench backfilled to trench bottom grade as hereinafter specified, with course sand, fine gravel or other suitable material.
- C. Bottom of trench grade shall be continued past ground surface deviations to avoid air pockets and low collection points in the line. The minimum cover specifications shall govern regardless of variations in ground surface profile and the occasional deeper excavation required at banks and other field conditions. Excavation shall be such that a uniform trench grade variation will occur in all cases where variations are necessary.
- D. Trench excavation shall comprise the satisfactory removal and disposition of all materials, and shall include all shoring and sheeting required to protect the excavation and to safeguard employees.
- E. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance back from edge of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted as directed by the Engineer/Architect. When excavated material is of a rocky nature and the topsoil or any other layer of excavated material is suitable for pipe bedding and backfill in the vicinity of the pipe, such material shall be separately stockpiled for use in such bedding and pipe backfill operations, unless satisfactory imported material is used.
- F. All excavations and backfill shall be unclassified and covered in the basic bid. No additional compensation will be allowed for rock or rubble encountered.
- G. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations to their original conditions in a manner acceptable to the Engineer/Architect.

2.3 PIPE INSTALLATION

- A. Sprinkler Mains: Sprinkler mains are that portion of piping from water source to electric valves. This portion of piping is subject to surges since it is a closed portion of the sprinkler system. Sprinkler mains shall be installed in a trench with a minimum of 18 inches of cover.

- B. Lateral Piping: Lateral piping is that portion of piping from electrical valve to sprinkler heads. This portion of piping is not subject to surges since it is an "open end" portion of the sprinkler system. Lateral piping shall be installed in a trench with a minimum of 18 inches of cover.
- C. Remove lumber, rubbish, and rocks from trenches. Provide firm, uniform bearing for entire length of each pipeline to prevent uneven settlement. Wedging or blocking of pipe will not be permitted. Remove foreign matter or dirt from inside of pipe before welding, and keep piping clean during and after laying pipe.
- D. PVC pipe shall not be installed where there is water in the trench, nor shall PVC pipe be laid when temperature is 40 deg. F or below or when rain is imminent. PVC pipe will expand and contract as the temperature changes. Therefore, pipe shall be snaked from side to side of trench bottom to allow for expansion and contraction.
- E. PVC pipe shall be cut with a hand saw or hack saw with the assistance of a square and sawing vice, or in a manner so as to ensure a square cut. Burrs at cut ends shall be removed prior to installation so that a smooth unobstructed flow will be obtained.
- F. All PVC pipe shall be installed with pipe markings facing the top of the trench.
- G. Thrust blocks shall be installed as indicated on the Drawings.

2.4 PVC PIPE AND FITTING ASSEMBLY

- A. Make solvent-welded joints following standards noted herein. Thoroughly clean pipe and fittings of dirt, dust, and moisture with an approved colored PVC primer before applying solvent.
- B. All plastic to plastic joints shall be solvent-weld joints or slip seal joints. Only the solvent recommended by the pipe manufacturer shall be used. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the Contractor's responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The Contractor shall assume full responsibility for the correct installation.
- C. Solvent weld joints shall be made in the following manner:
 - 1. Thoroughly clean the mating pipe and fittings with approved cleaner and a clean dry cloth.
 - 2. Apply a uniform coat of solvent to the outside of the pipe with a non-synthetic bristle brush or applicator.
 - 3. Apply solvent to inside of the fitting in a similar manner.
 - 4. Re-apply a light coat of solvent to the pipe and quickly insert it into the fitting.
 - 5. Give the pipe or fitting a quarter turn to ensure even distribution of the solvent and make sure that the pipe is inserted to the full depth of the fitting socket.
 - 6. Hold in position for 15 seconds.
 - 7. Wipe of excess solvent that appears at the outer shoulder of the fitting. Cure 24 hours before charging system with water.

- D. PVC to Metal Connection: Work metal connections first. Use a non-hardening pipe dope such as Permatex No. 2 or "Teflon" tape on threaded PVC to metal joints. Use only light wrench pressure. All plastic to metal joints shall be made with plastic male adapters.
- E. Threaded PVC Connections: Where required, use threaded PVC adapters into which pipe may be welded.

2.5 CONTROL WIRE INSTALLATION

- A. All electric control cables shall be of size as shown on the Drawings and/or as specified and shall be installed in the piping trenches wherever possible.
- B. Install wire in the pipe trench as detailed on the Drawings.
- C. Wire shall be placed in the trench as loose as possible and with as much slack as possible to allow for expansion and contraction of the wire. Where it is necessary to run wire in a separate trench, the wire shall have at least twelve (12) inches of cover.
- D. All wire connections at remote control valves, either direct buried or in boxes, and at all splices shall be left with sufficient slack so that in case of repair, the splice may be brought to the surface without disconnecting the wires. Slack shall be coiled in approximately 1" wraps.
- E. Each remote control valve or group of remote control valves, which are to be connected to one station of a controller, shall have wire sizes as shown in the wiring diagrams on the Drawings or as specified. All remote control valves, what are to be connected to the same controller, shall be connected to a common ground wire system entirely independent of the common ground wire system of all other controllers. Only those remote control valves which are being controlled by one specific controller, shall be connected to that controller's common ground wire system.
- F. All control wire less than 500 feet in length shall be continuous without splices or joints from the controller to the valves. Connections to the electric valves shall be made within 18 inches of the valve using connectors specified in Paragraph 2.4 of this section, unless otherwise approved by the Engineer/Architect in writing.
- G. The Contractor shall obtain the Engineer/Architect's approval for wire routing when installed in a separate ditch. Control wires may be installed in a common ditch with piping; however, wires must be installed underneath mainline piping.
- H. All wire passing under existing or future paving, sidewalk, construction, etc., shall be encased in 1" minimum PVC Schedule 40 conduit extending at least twelve (12) inches beyond edges of paving, sidewalks, or construction.

2.6 POP-UP SPRAY, MICRO-SPRAY, ROTORY AND BUBBLER HEADS (PURPLE FOR NON-POTABLE IRRIGATION)

- A. Provide heads and nozzles as specified and install in locations as shown on the Contract Drawings.
- B. All heads of a particular type and for a particular function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification, in such a position that they can be identified without being removed from the system. All sprinkler heads and quick coupling valves shall be set perpendicular to finished grades unless otherwise indicated on the Drawings.
- C. Pop-up spray and micro-spray heads shall be installed on a swing joint pipe connector as detailed. Rotary heads shall be installed on a double swing joint connected to the lateral pipe. Bubbler shall be a tree well flexible riser-bubbler head on a flex pipe. Provide wire staple to secure the bubbler to the top of the root ball. Keep heads a minimum of 4 inches from paved surfaces.
- D. Heads shall be installed with underside of flange flush with the finished grade.
- E. Contractor will be required to adjust heads as necessary after establishment of grass or other plant material.

2.7 MANUAL VALVES

- A. Manual valves shall be sized and located where shown on the Drawings.
- B. Valve boxes shall be adjusted to be flush with finished grade.
- C. Valve boxes shall be properly supported and of sufficient construction that tractors, mowers or
- D. other equipment crossing over the boxes will not push boxes down and damage the pipe, valve, or box.

2.8 VALVE AND VALVE BOX PLACEMENT (PURPLE FOR NON-POTABLE IRRIGATION)

- A. A ball valve shall precede each valve to provide shut off for repair of valves.
- B. All manual, electric, and quick coupling valves shall be in boxes as specified in Paragraph 2.6 of this section, and shall be set with a minimum of six (6) inches of space between their top surface and the bottom of the valve box. The base of the box shall be filled with pea gravel per manufacturer's installation instructions.
- C. Valves shall be fully opened and fully closed to ensure that all parts are in operating condition.
- D. Valve boxes shall be set plumb, vertical, and concentric with the valve stem.
- E. Any valve box which has moved from this required position so as to prevent the use of the operating wheel of the valve shall be reset by the Contractor at his own expense.

2.9 ELECTRIC CONTROLLER

- A. Electric controller shall be located as shown on the Drawings and shall be capable of operating the number of stations indicated.
- B. The system is designed to operate multiple sections at a time, unless otherwise noted on the Drawings in strict accordance with the manufacturer's published installation instructions.

2.10 ELECTRIC REMOTE CONTROL VALVES

- A. Remote control valves shall be located and sized as shown on the Drawings. All electrical connections shall be made when the weather is dry with connection kits as specified in Paragraph 2.4 of this section in strict accordance with manufacturer's recommended procedures. All remote control valves shall be installed in a horizontal position, in accordance to the manufacturer's published installation instructions.
- B. It shall be the responsibility of the Contractor to furnish and install the proper size wire on each of the low voltage circuits from the master control center to the various electric remote control valves.
- C. Consideration shall be given to each circuit for allowance of voltage drop and economy consistent with accepted practices of electrical installation. Under no circumstances shall the voltage of any branch circuit be reduced more than proper due to length of run exceeding the maximum allowable for the wire size used. "Up-sizing" wire to compensate for voltage drop shall be at the Contractor's expense, whether or not indicated on the Drawings.

2.11 BACKFILL AND COMPACTION

- A. After system is operating and required tests and inspections have been made, the trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, gravel, soft shale, or other approved materials, free from large clods of earth or stone. Rock, broken concrete, or pavement, and large boulders shall not be used as backfill material. The backfill shall be thoroughly compacted and made flush with the adjacent soil level.
- B. Compact trenches in areas to be planted by thoroughly flooding the backfill with water. Compact all other areas by flooding or hand tamping. The jetting process may be used in areas when flooding.
- C. Backfill for all trenches, regardless of the type of pipe covered, shall be compacted to a minimum of 90% density.
- D. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for compaction, then refilled and compacted with the surface restored to the required grade and left in a completed surface condition as described above.

- E. Specifically tamp backfill under heads and around the flange of heads in a one (1) foot radius by a suitable means after trench backfill has dried from flooding to prevent heads loosening in the ground.

2.12 FINAL ADJUSTMENT

- A. After installation has been completed, make final adjustment of sprinkler system prior to Engineer/Architect's final inspection.
- B. Completely flush system to remove debris from lines by removing nozzle from heads on ends of lines and turning on system.
- C. Check sprinklers for proper operation and proper alignment for direction of throw.
- D. Check each new section for operating pressure and balance to other sections by use of flow adjustment on top of each valve.
- E. Check nozzling for proper coverage. Prevailing wind conditions may indicate that arc or angle of spray should be other than as shown on the Drawings. In this case, change nozzles to provide correct coverage and furnish as-built data to Engineer/Architect with each change.
- F. After system is thoroughly flushed and ready for operation, each section of sprinklers shall be adjusted to control pressure at heads. Use the following method, one section at a time:
 - 1. Remove last head on section and install a temporary riser above grade. Install tee with pressure gauge attached on top of riser and re-install head with nipple onto tee.
 - 2. Correct operating pressure at last head of each section as follows: Spray Heads - 20-25 psi; rotor heads - 30 to 40 psi (and as recommended by the manufacturer).
 - 3. After replacing head, at grade, tamp thoroughly around head.
- G. Prior to final inspection, cycle the system through three (3) complete watering schedules of not less than twenty (20) minutes each for sprinklers and three (3) hours each for drip to assure proper function of sprinklers, valves and controller.

2.13 CLEAN-UP

- A. The Site shall be thoroughly cleaned of all waste materials and all unused or salvaged materials, equipment, tools, etc.
- B. After completion of the work, areas disturbed shall be leveled and the Site shall be raked clean and left in an orderly condition.
- C. TEMPORARY IRRIGATION FOR GRASS ESTABLISHMENT

- D. If the permanent irrigation system is inoperable the Contractor shall provide temporary irrigation for all new turf areas. Temporary irrigation may include equipment securely staked above grade. It shall be the Contractor's responsibility to provide complete, consistent temporary coverage in order to establish a viable, mowable stand of grass. Any above grade equipment shall be removed by the Contractor upon acceptance of the turf by the Engineer/Architect.

END OF SECTION 328401

SECTION 329200 TURFGRASS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK AND RELATED DOCUMENTS

- A. Furnish all work and materials, appliances, tools, equipment, facilities, transportation and services required and incidental thereto, as shown on drawings and/or specified herein including but not limited to; seed bed preparation, fertilization, installation and uniform establishment of hydromulch and sod materials, subsequent maintenance requirements.
- B. Related Work Specified Elsewhere:
 - 1. Plants: Section 329300
- C. It is the responsibility of the Contractor to establish a dense, top quality lawn of permanent grasses as specified. Any part of the area that fails to show a uniform germination shall be reseeded/resodded and such reseeding/resodding shall continue until a dense lawn area is established. The Contractor shall provide all maintenance of the lawn areas as described below until Final Acceptance.

1.2 QUALITY ASSURANCE

- A. Work in this Section is to be performed by a single firm specializing in commercial landscape work of similar size and quality with a minimum of five (5) years experience. The Landscape Architect shall review qualifications and approve subcontractor prior to commencing work.
- B. All chemical applications shall be performed in accordance with current county, state, and federal laws, utilizing approved materials and methods of application. These applications shall be performed under the supervision of a Licensed Certified Applicator.
- C. All seed must meet the requirements of the U.S. Department of Agriculture Rules & Regulations as set forth in the Federal Seed Act and the Texas Seed Law.
- D. All sod must be laid within forty-eight hours of cutting and immediately upon arrival to the project site. Stack sod roots to roots and protect from damage by exposure to environmental conditions. If laying of sod is delayed more than four hours after arrival to the site it must be stored under shade and kept moist. Do not tear, stretch or drop sod. Do not allow soil to break free of turf roots.
- E. Suspend all work in this Section if conditions of drought, excessive moisture, high winds or extreme or prolonged cold exist.

1.3 WARRANTY AND MAINTENANCE

- A. The Contractor shall maintain all plant material described in this Section from the date of installation and continue ninety (90) days after written approval of substantial completion is received from the Landscape Architect.
- B. If a uniform lawn has not been established after ninety (90) days the Contractor shall take additional actions to meet the turf establishment requirement of these Contract Documents. The Contractor shall provide a written statement to the Landscape Architect detailing a course of action to establish a lawn.
- C. Maintenance period work shall include the following tasks completed weekly:
 - 1. Provide insect and disease control to maintain health of plants.

2. Dispose of all maintenance debris/clippings off-site. Owner's dumpsters shall not be used for disposal.
 3. Keep all site areas tidy and free of grass clippings, mulch or other foreign materials.
 4. Reapply hydromulch or resod as necessary to achieve uniform coverage.
 5. Mow turf areas to maintain a 2" maximum height. However, not more than 1/3 of the grass leaf shall be removed at any one cutting and cutting shall not be fewer than ten (10) days apart.
 6. Trim/edge all turf areas that abut edging, plant beds, pavement, etc.
 7. Fertilize as indicated in this Section.
 8. Assure adequate watering by utilizing irrigation system, if any. Monitor and adjust the irrigation system as needed.
 9. Hand water all turf if irrigation system is not functional or does not exist.
- D. The Contractor shall warranty all turf areas for a period of three months from the date of written Final Acceptance. The Landscape Architect shall provide a letter indicating Final Acceptance of the turf areas.

1.4 SUBMITTALS

- A. The Contractor shall submit manufacturer's specifications for fertilizers, soil amendments and seed mixtures/percentages. Also include sod inspection certificates from the Texas Department of Agriculture and one sod delivery ticket per truckload. Sod delivery tickets shall indicate sod species, nursery certification and the date and time of cutting.
- B. The submittal shall include the manufacturer's name, model number, and manufacturer's installation recommendation, if applicable, for each proposed item.
- C. No partial submittal will be accepted and submittals shall be neatly bound into a brochure and logically organized. After the submittal has been approved, substitutions will not be allowed except by written consent of the Landscape Architect.
- D. Approval of the submittals are required prior to delivery of any materials to the job site.
- E. Shop drawings shall include dimensions, elevations, construction details, arrangements, and capacity of equipment, as well as manufacturer's installation recommendations.

1.5 APPROVAL OF PLANT MATERIAL

- A. All plant material shall be approved by the Landscape Architect prior to installation. At no time shall any approval impair the right of further inspection and rejection during the progress of the work or contract life for failure to conform to the listed size and condition requirements or latent defects, diseases or injuries. Rejected plant materials shall be promptly removed from the site by the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil shall be in accordance to Section 329300.
- B. Sod shall be premium #1 certified sod, grown in a sod nursery on clayey soil, at least one year old, with a heavy top, strong well-knit root system and free of weeds and disease. Refer to drawings for type of sod required.
- C. Seed shall be fresh, clean, new crop seed. Apply uniformly at the following rates for type of seed and planting date:

| TYPE | APPLICATION RATE POUNDS/AC | SEEDING DATE |
|-------------------------------------|-------------------------------|-----------------------------|
| Hulled Common Bermuda Grass 98/88 | 40 | January 1 to March 31 |
| Unhulled Common Bermuda Grass 98/88 | 40 | |
| Hulled Common Bermuda Grass 98/88 | 40 | April 1 to September 30 |
| Hulled Common Bermuda Grass 98/88 | 40 | October 1 to December 31 |
| Unhulled Common Bermuda Grass 98/88 | 40 | |
| Annual Rye Grass (Gulf) | 30 | |

- D. Fertilizer shall be water soluble with an analysis of 12 percent Nitrogen, 4 percent Phosphoric Acid and 8 percent Potash. The fertilizer shall be delivered to the site in fully labeled containers. Fertilizer shall be kept dry prior to being used.
- E. Mulch shall be virgin wood cellulose fiber made from whole wood chips. Within the fiber mulch material, at least 20 percent of the fibers will be 10.7 mm in length and .27 mm in diameter. Rate of application shall be 2000 pounds per acre. Mulch shall have a non-toxic green dye to guide in application. Hay or straw shall not be used.
- F. Tackifier shall be equal to Terra Tack. The tackifier shall be applied at a rate of 40 pounds per acre. Terra Type III, or approved equal, shall be used on slopes exceeding 10% and Terra Type I, or approved equal, shall be used in all other areas.
- G. Wetting agent shall be potable water.
- H. Herbicide shall have an active ingredient of 41% glyphosate. The Contractor shall follow all manufacturer's warnings and application instructions.

PART 3 - INSTALLATION

3.1 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed. Notify the Landscape Architect of unsatisfactory conditions. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected and the Landscape Architect has provided written acceptance. Beginning work indicates acceptance of the site as satisfactory by the installer.

3.2 PREPARATION

- A. Site Preparation: Compacted or unsuitable soils and sub-soils from construction activities must be ripped and tilled until a loose, friable and free-draining condition is met. All existing weeds, grass, stabilized sub-base material, rubble, excavated soil and other material shall be removed from the site and disposed of by the contractor prior to starting any new landscape work. All stones over one (1) inch in any dimension in the top two (2) inches of soil shall be removed. Soil conditions around entire site must be approved by the Landscape Architect prior to rough and finish grading operations. The Contractor shall not install any fill or topsoil in turf areas prior to site condition approval by the Landscape Architect.
- B. Turf Area Preparation: Grade areas to finish grades, filling as needed or removing surplus material. Float all turf areas to a smooth, uniform grade as indicated in the Contract Documents. Add compost and incorporate as stated on Plans. All turf areas shall slope to drain away from structures and planting beds. Areas where no grades are shown shall have a smooth and continual grade between fixed elements and elevations shown. The Contractor shall ensure proper drainage around all structures and adjust grades as necessary or as directed by the Landscape Architect. Lightly compact all turf areas with weighted roller to assure future settling will not occur.

- C. Turf Areas and Herbicide Application: All turf areas shall be free of weeds, grass, insects, or any other deleterious material prior to bed preparation. Contractor shall herbicide all turf areas at least two times prior to installation of any new material (topsoil or seed/sod). The Contractor shall wait seven (7) days from last herbicide application before proceeding with hydromulch or sod material installation.

3.3 INSTALLATION – HYDROMULCH

- A. Prior to commencement of seeding operations, the Contractor shall protect all stationary items from overspray. Any overspray shall be immediately removed from any stationary object while still wet.
- B. The Contractor shall obtain approval of hydromulch area from Landscape Architect prior to application. Immediately after approval begin hydromulch application to reduce potential for erosion and excessive weed growth.
- C. Turf areas shall be seeded with an approved mechanical hydromulcher. Hydraulic equipment used for the application of fertilizer, seed and slurry of prepared wood fiber mulch shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend and homogeneously mix a slurry containing up to forty (40) pounds of fiber plus a combined total of seventy (70) pounds of fertilizer solids for each 100 gallons of water. The discharge line shall be equipped with a set of hydraulic spray nozzles which provide even distribution of the slurry on the area to be seeded. The slurry tank shall have a minimum capacity of eight hundred (800) gallons. The Landscape Architect may authorize equipment with a smaller tank capacity. Apply a visibly uniform coat of slurry mixture to the prepared seed bed.
- D. Keep hydromulched areas moist during germination period. Adjust watering schedule as needed or as directed by the Landscape Architect.
- E. After first cutting water hydromulched areas twice the first week to a minimum depth of six (6) inches with a fine spray and once per week thereafter as necessary to supplement natural rain to the equivalent of one (1) inch or to a six (6) inch depth.
- F. Water for watering purposes shall be provided by the Owner at no cost to the Contractor. The Contractor shall provide equipment needed to connect to source, transport and distribute water.
- G. After germination period all areas that fail to show a uniform stand of grass shall be re-hydromulched and shall be done repeatedly until a uniform stand of grass has been approved by the Landscape Architect.

3.4 INSTALLATION – SOD

- A. The Contractor shall obtain approval of sod area from Landscape Architect prior to installation. Immediately after approval begin sod installation to reduce potential for erosion and excessive weed growth.
- B. Always lay sod perpendicular to the slope and abut tightly together. Stagger strips of sod so that transverse joints are offset a minimum of eight (8) inches.
- C. Roll all sod with a weighted roller weighing approximately three hundred (300) lbs. to sufficiently set sod roots into underlying soil.
- D. Water the sod with an irrigation system only. Monitor the health of the sod material and adjust water needs accordingly or as directed by Landscape Architect.
- E. Sodded areas shall have fertilizer applied in two (2) applications with a thorough watering immediately following each application. The first application shall be one (1) week before the sod install at the rate of 35 pounds per 1,000 square feet harrowed into the top two (2) inches of seed bed. The second application shall be done at the rate of 25 pounds per 1,000 square feet, immediately following the second mowing.

3.5 CLEANING AND PROTECTION

- A. The Contractor shall perform all necessary cleaning and removal of excess soil, debris, equipment, etc., during installation and upon completion of the work. The Contractor shall immediately repair any damage resulting from turf establishment operations without cost to the Owner.
- B. The Contractor shall protect turf areas from damage, theft, erosion, washout, settlement or other causes until final acceptance. The above damages shall be repaired by the Contractor at no cost to the Owner.

PART 4 - METHOD OF MEASUREMENT

MEASUREMENT:

Turfgrass as described in this section will be paid for on a lump sum basis wherein no measurement will be made.

PART 5 - BASIS OF PAYMENT

PAYMENT:

- A. Turfgrass will be paid for at the Contract lump sum, which price will be full compensation for furnishing and installing equipment; shop drawings; providing all submittals and warranties; furnishing all labor, materials, tools, equipment; and incidentals necessary to complete the work as described in this section and related other sections of these Contract Documents, as well as maintenance until final acceptance.

END OF SECTION 329200

SECTION 329300 PLANTS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK AND RELATED DOCUMENTS

- A. Furnish all work and materials, appliances, tools, equipment, facilities, transportation and services required and incidental thereto, as shown on the Drawings and/or specified herein including but not limited to; the procurement and transportation of living plants, the excavation and preparation of all planting beds and planting of all materials, mulching, watering, protection, maintenance guarantee period, bed edging, planting soil/mixes, fertilizer, mulch, trees, palms, shrubs, groundcovers, plant material replacements for all Contractor supplied plant materials, miscellaneous landscape materials.
- B. Related Work Specified Elsewhere:
 - 1. Turf and Grasses: 329200

1.2 QUALITY ASSURANCE

- A. The following Codes, Regulations, Reference Standards, and Specifications apply to work included in this section:
 - 1. "Hortus Third," 1976.
 - 2. Texas Association of Nurserymen, Grades and Standards for Nursery Stock
 - 3. "American Standard for Nursery Stock," ANSI Z60.1-1900.
 - 4. National Arborist Association Standards
 - 5. "Plants of Deep South Texas – A Field Guide to the Woody and Flowering Species"
- B. Landscape work to be performed by a single firm specializing in commercial landscape work of similar size and quality with a minimum of five (5) years experience. The Landscape Architect shall review qualifications and approve subcontractor prior to commencing work.

1.3 WARRANTY AND MAINTENANCE

- A. The Contractor shall warranty groundcover/shrubs for three months and trees/palms for one year after final acceptance. If plant material is deemed dead or unrecoverable by the Landscape Architect the Contractor will be notified in writing as such. The Contractor shall remove and replace the plant material within two weeks of the notification.
- B. The Contractor shall maintain all plant material described in this Section for ninety days after written approval of substantial completion is received from the Landscape Architect.
- C. Maintenance period work shall include the following tasks completed weekly:
 - 1. Remove and replace dead plant material. Prune plants to remove dead wood and to maintain health of plants.
 - 2. Maintain all mulched areas at a 3 in. depth. Remove weeds and grass from shrub and ground cover areas and from watering basins.
 - 3. Provide insect and disease control to maintain health of plants.
 - 4. Adjust or replace staking as required.
 - 5. Dispose of all maintenance debris/clippings off-site. Owner's dumpsters shall not be used for disposal.
 - 6. Keep all paved areas clear and free of grass clippings, mulch or other foreign materials.
 - 7. Remove staking materials at end of maintenance period and deliver to Owner.

1.4 SUBMITTALS

- A. The Contractor shall submit manufacturer's specifications for fertilizers, soil amendments, seed mixtures/percentages; all sources for plant materials; a one foot section of edging (as specified on the Drawings); and one pound bag samples each of topsoil, mulch and compost. The submittal shall include the manufacturer's name, model number, and manufacturer's installation recommendation, if applicable, for each proposed item in accordance with Section 01300.
- B. No partial submittal will be accepted and submittals shall be neatly bound into a brochure and logically organized. After the submittal has been approved, substitutions will not be allowed except by written consent of the Landscape Architect.
- C. Approval of the submittals are required prior to delivery of any materials to the job site.
- D. Shop drawings shall include dimensions, elevations, construction details, arrangements, and capacity of equipment, as well as manufacturer's installation recommendations.

1.5 PROTECTION OF ITEMS TO REMAIN

- A. Prior to commencing work the Contractor shall furnish and install tree protection fencing per the Tree Protection Details and Notes sheet that is part of the construction set of plans. No work under this contract may begin until this fencing is in place and approved in writing by the Landscape Architect.
- B. Trees that are to remain on site but be transplanted to a new location shall have orange construction fencing installed at the tree's dripline.
- C. No trucks, machinery, stockpiled or staged material shall be placed or driven within the drip line of any plant material unless that drip line extends over an imperviously surfaced area. The Landscape Architect will determine if plant replacement or other repair is needed to restore the affected area to pre-construction conditions at the sole cost to the Contractor.
- D. The Contractor shall adjust depth of earthwork and loaming when working immediately adjacent to any of the aforementioned features in order to prevent disturbing tree roots, undermining walks and pavements, and damage in general to any existing or newly incorporated item.
- E. Where excavating, fill or grading is required within the branch spread of trees that are to remain, the work shall be performed as follows:
 - 1. TRENCHING: When trenching occurs around trees to remain, the tree roots shall not be cut but the trench shall be tunneled under or around the roots by careful hand digging and without injury to the roots.
 - 2. Adjust grades around trees per standard local municipality requirements.

1.6 APPROVAL OF PLANT MATERIAL

- A. All plant material shall be approved by the Landscape Architect prior to installation. At no time shall any approval impair the right of further inspection and rejection during the progress of the work or contract life for failure to conform to the listed size and condition requirements or latent defects, diseases or injuries. Rejected plant materials shall be promptly removed from the site by the Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Plant materials shall conform to the following requirements:

1. Plants shall be true to name. The standard names are those adopted by the American Joint Committee on Horticultural Nomenclature. No substitution of species or varieties shall be accepted without the written consent of the Landscape Architect.
 2. Plants shall have a normal habit of growth and shall be typical of their species unless the general shape and overall character of a particular plant is specifically noted in the Plant List on the Contract Documents.
 3. Plants shall be certified healthy, freshly dug, vigorous and free from defects, decay, disfiguring roots, sun scale injuries, abrasions of the bark, plant diseases insect pests, eggs, or larvae.
 4. All plants shall have been grown under climatic conditions similar to those in the locality of the project for at least two (2) years and shall have normal healthy root systems, having been subjected to proper transplanting.
 5. Plants shall not be pruned prior to delivery.
 6. Balled and burlapped ("B & B") plants shall have firm, natural balls of soil of a diameter to conform to the above standards, but large enough to encompass sufficient fibrous feeding roots to insure full recovery and development of the plants. Plants grown in sand are not acceptable.
 7. All precautions, which are customary in good nursery practice, shall be taken to insure the arrival of the plant material in good condition for successful growth. Plant material which arrives to the construction site poorly packed, with roots in a dry condition and/or leaves in a dehydrated condition will not be accepted.
 8. All plants shall be freshly dug. All plants shall be typical of their species or variety and shall have a normal habit of growth unless otherwise specified. Trees shall have straight trunks and all old abrasions and cuts shall be completely calloused over.
 9. Plants shall have a well-developed fibrous root system.
 10. Measurement: Trees and shrubs shall be measured when their branches are in normal position. Height and spread dimensions specified refer to the main body of the plant, and not from branch or root tip to tip. Caliper of trees shall be taken 6' above tree root flare.
 11. Palms: All new palms shall be field dug or containerized material in specified sizes shown on the Contract Documents. All palms shall have good form (straight trunks) consistent of its species, free of scares/abrasions/burn marks and disease and insects, with large healthy root systems. Rootballs sizes for B&B material must meet the following minimum specifications:
 - a. Sabal Palms – 12" greater than trunk O.D., 24" height
 - b. Washingtonia Palms - 8" greater than trunk O.D., 24" height
 - c. Chinese Fan, Mediterranean Fan Palms, Others - 30" diameter, 30" height
- B. Fertilizer: 13-13-13 Osmocote slow release fertilizer granules or approved equal.
- C. Planting tablets: Agriform (20-10-15) 21 gram slow release fertilizer tablets or approved equal.
- D. Compost: Premium grade compost
- E. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0; organic matter to exceed 1.5%, magnesium to exceed 100 units;

phosphorus to exceed 150 units; potassium to exceed 120 units; soluble salts/conductivity not to exceed 900 ppm/0.9 mmhos/cm in soil.

- F. Mulch: Grade A cypress bark; long, fibrous bark strands free from wood chips.
- G. Staking material:
 - 1. Commercial grade rubber chain-locks.
 - 2. Commercial grade T-Posts, 1.25 ga., 8' Ht., black (do not drive through rootball). Include plastic cap on all T-posts, cap color to match T-Post color.
- H. Edging:
 - 1. 4"x36" commercial grade aluminum edging. All edging that terminates at a walkway shall have the top edge rounded.
- I. Planting Mix: 75 percent sandy-loam topsoil; 25 percent premium compost; (3:1 ratio by volume); and specified fertilizer or planting tablets. Provide a mix with a uniform texture without lumps and containing no stones, sticks, roots or other foreign material.

PART 3 - INSTALLATION

3.1 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed. Notify the Landscape Architect of unsatisfactory conditions. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected and the Landscape Architect has provided written acceptance. Beginning work indicates acceptance of the site as satisfactory by the installer.

3.2 EXECUTION

- A. Site Preparation: Compacted or unsuitable soils and sub-soils from construction activities must be ripped and tilled until a loose, friable and free-draining condition is met. All existing weeds, grass, stabilized sub-base material, rubble, excavated soil and other material shall be removed from the site and disposed of by the contractor prior to starting any new landscape work. Soil conditions around entire site must be approved by Landscape Architect prior to rough and finish grading operations. The Contractor shall not install any fill or topsoil in landscape areas prior to site condition approval by Landscape Architect.
- B. Bed Preparation and Herbicide Application: All planting areas shall be free of weeds, grass, insects, or any other deleterious material prior to bed preparation. Contractor shall herbicide all planting areas with 'RoundUp' or approved equal at least two times prior to installation of any new plants. Pre-emergent herbicide shall be applied after planting and before placement of mulch.
- C. Planting Beds: Excavate 12" of existing soil within planting beds and replace with 8" of planting mix. Final grades within all planting beds shall be 3" below adjacent curbs to allow for mulch. Contractor to ensure positive drainage throughout all landscape areas. Adjust grades as necessary to direct water away from planting beds. Report any discrepancies on all drainage issues in writing to the Landscape Architect. The Landscape Architect shall approve planting bed grades prior to planting operations.
- D. Edging: Edging shall be installed as shown on the Drawings. Edging shall allow for drainage points to ensure free drainage away from all structures and walkways. Edging shall be set flush with adjacent paving, sidewalks or driveways.
- E. Turf Areas: Scarify, float and fine grade all areas to receive sod or hydromulch for approval by Landscape Architect prior to placement of sod or application of hydromulch. Supply additional topsoil as necessary to fill any/all low areas and ensure positive drainage away from planting beds.
- F. Berms and Mounding: Supply topsoil and construct berms as indicated on the Drawings.

- G. Berms shall have a maximum slope of 1:4. Landscape Architect to approve berming and mounding prior to planting operations. Berms shall be compacted in 6" lifts.
- H. Planting Operations:
1. Installation:
 - a. Excavate planting pit to depth and width indicated on Contract Documents.
 - b. Set root ball on puddle/settled bottom of planting pit. Remove burlap, rope, wire, and all other wrapping material from top of ball. Completely remove any binding rope which is not biodegradable.
 - c. Fill planting pit 2/3 full with planting mix, soak with water and allow to settle, and add fertilizer tablets as detailed. Finish filling pit with planting mix and tamp lightly. Do not place fertilizer tablets at bottom of planting pit.
 - d. Construct a watering basin as detailed on the Drawings and described below. Water-in to completely saturate the root ball and planting mix. Add planting mix where any settling or air pockets occur and saturate with water.
 - e. Stake all trees/palms immediately after planting as detailed. Staking to be maintained throughout the maintenance period.
 - f. Palms: New Washingtonia palms shall be cleaned (skinned) completely of their leafstem bases and fibers to a height 4 feet below the crown. Sabal palms shall be planted with their leafstem bases remaining but cleaned and trimmed evenly. All palms shall be planted with several petioles or fronds tied up straight with natural twine. Remaining fronds shall be trimmed or 'hurricane cut' to lighten wind load on terminal bud. Contractor is responsible for removing or cutting the twine supporting the fronds as directed by the Landscape Architect.
- I. Watering Basins: Watering basins for all trees/palms shall be constructed in a ring shape around each tree or palm trunk. This earthen berm shall be constructed 6" in height and 36" in diameter so as to hold water and allow infiltration around root ball. A minimum of 4 inches of cypress mulch shall be placed within the watering basin. Watering basins must be maintained and kept free of weeds during the entire maintenance period. No mulch shall come in contact with the tree trunk.
- J. Pruning Operations:
1. After planting, the branches of deciduous stock shall be pruned to balance the loss of roots while retaining the natural form of the plant type according to best horticultural practice.
 2. Trees shall be pruned by removing all dead wood, all surplus, badly formed and interfering limbs. In general, 1/5 of the branches shall be removed but the proportion shall, in all cases, be subject to the approval of the Landscape Architect. Broken, damaged and unsymmetrical branches shall be removed or cut back to ensure healthy and symmetrical growth of new wood. In the case of multiple leaders, the one which will best promote the symmetry of the trees shall be preserved and the remainder shall be removed or cut back so that they will not compete with the selected leader. Surrounding top branches shall be cut back to conform to the leader trimming. Branches to be cut back shall be cut off at the point beyond a lateral shoot or bud a distance of not less than 1/2 the diameter of the supporting branch. The cut shall be made on an angle slopping in the direction of the lateral shoot and in no case shall stubs be left. All cut surfaces over one inch in diameter shall be painted with tree wound dressing.
- K. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance back from edge of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted as directed by the Landscape Architect. When excavated material is of a rocky nature and the topsoil or any other layer of excavated material is suitable for pipe bedding and backfill in the vicinity of the pipe, such material shall be separately

stockpiled for use in such bedding and pipe backfill operations, unless satisfactory imported material is used.

- L. All excavations and backfill shall be unclassified and covered in the base bid. No additional compensation will be allowed for rock encountered.
- M. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations to their original conditions in a manner acceptable to the Landscape Architect.

3.3 CLEANING AND PROTECTION

- A. The Contractor shall perform all necessary cleaning and removal of excess soil, debris, equipment, etc., during installation and upon completion of the work. The Contractor shall immediately repair any damage resulting from planting operations without cost to the Owner.
- B. The Contractor shall protect landscape plants from damage or theft until final acceptance.

PART 4 - METHOD OF MEASUREMENT

MEASUREMENT:

Landscape Planting as described in this section will be paid for on a lump sum basis wherein no measurement will be made.

PART 5 - BASIS OF PAYMENT

PAYMENT:

- A. Landscape Planting will be paid for at the Contract lump sum, which price will be full compensation for furnishing and installing equipment; shop drawings; providing all submittals and warranties; furnishing all labor, materials, tools, equipment; and incidentals necessary to complete the work as described in this section and related other sections of these Contract Documents, as well as maintenance until final acceptance.

END OF SECTION 329300

SECTION 33 11 00 - WATER DISTRIBUTION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

Providing labor, materials, services, equipment, and other necessary items required for the construction of water systems. This shall include, but not be limited to the following: pipe and fittings for site water line including domestic water line and fire sprinkler system water line, valves and fire hydrants, setting line locations, elevations, and grades for water distribution systems work and control system for duration of work including careful maintenance of benchmarks, property corners, monuments, or other reference points.

1.2 RELATED SECTIONS

- A. Section 31 23 00 - Excavating, Backfill and Compacting for Utilities.
- B. Section 31 20 00 - Aggregate Materials.
- C. Section 33 39 00- Sewer Structures.
- D. Section - Fire Protection. (See Architectural/Building Specifications)
- E. Local Governing Authority and Code Requirements.
- F. All Necessary Construction Permits.
- G. Construction Drawings

1.3 REFERENCES

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop.
- B. ANSI/ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- E. ANSI/ASTM D2466 - Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
- F. ANSI/AWS A5.8 - Brazing Filler Metal.
- G. ANSI/AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
- H. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and other liquids.
- I. ANSI/AWWA C111- Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
- J. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- K. ANSI/AWWA C500 - Gate Valves, 3 inch through 48 inch NPS, for Water and Sewage Systems.
- L. ANSI/AWWA C502 - Dry Barrel Fire Hydrants.
- M. ANSI/AWWA C504 - Rubber Seated Butterfly Valves.
- N. ANSI/AWWA C508 - Swing-Check Valves for Waterworks Service, 2 inch through 24 inch NPS.
- O. ANSI/AWWA C509 - Resilient Seated Gate Valves 3 inch through 12 inch NPS, for Water and Sewage Systems.
- P. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Appurtenances.
- Q. ANSI/AWWA C606 - Grooved and Shouldered Type Joints.
- R. ANSI/AWWA C651 - Disinfecting Water Mains
- S. ANSI/AWWA C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch, for Water.
- T. ASTM B88 - Seamless Copper water Tube.
- U. ASTM D1785 - Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- V. ASTM D2241 - Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR).
- W. D2855 - Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.
- X. ASTM D2922 - Test Methods for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth).
- Y. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
- Z. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
- AA. ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter.
- BB. AWWA C901 - Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, 1/2 inch through 3 inch, for water.

- CC. AWWA C600-82 - Hydrostatic Testing
DD. UL 246 - Hydrants for Fire Protection Service.

1.4 SUBMITTALS

- A. Product Data: Provide Engineer with data on pipe materials, pipe fittings, hydrants, valves and accessories.
B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.

1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with utility company and/or municipality requirements.
B. Valves: Manufacturer's name and pressure rating marked on valve body.

PART 2 PRODUCTS

2.1 PIPE

- A. Pipe sizes less than 3 inch that are installed below grade and outside building shall comply with one or combination of the following:
1. Seamless Copper Tubing: Type "K" soft copper to comply with ASTM B 88-62 and installed with wrought copper (95-5 Tin Antimony solder joint) fittings in accordance with ASTM B16.22.
 2. Polyvinyl Chloride (PVC) Water Pipe: Pipe shall conform to ASTM D-2241 with an SDR 21 rating and shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 1784 classification. Pipe joints shall be integrally molded bell ends in accordance with ASTM D 3139 with factory supplied elastomeric gaskets and lubricant.
- B. Pipe sizes 3 inch and larger that are installed below grade and outside building shall comply with one of the following:
1. Gray Cast Iron Water Pipe: In accordance with ANSI A21.6, thickness class 22, and pressure class 150. Fittings shall be either mechanical joint or push-on joint and shall comply with ANSI A21.10 or ANSI A21.11.
 2. Ductile Iron Water Pipe: In accordance with ANSI A21.51, Fittings shall be either mechanical joint or push-on joint complying with ANSI A21.10 or ANSI 21.11 (AWWA C-151) (CLASS 50).
 3. Polyvinyl Chloride (PVC) Water Pipe: Pipe shall meet the requirements of AWWA C-900 and comply with ASTM D 2241, rated SDR 21 (Class 150). Pipe shall be continually marked as for smaller pipes. Pipe joints shall be integrally molded bell ends in accordance with ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.

2.2 GATE VALVES - 2 Inches and Larger

- A. Manufacturers:
Mueller Resilient Seat Gate Valves or approved equal.
- B. ANSI/AWWA C509, Iron body, bronze mounted double disc, parallel seat type, non-rising stem with square nut, single wedge, resilient seat, flanged or mechanical joint ends, control rod, post indicator where indicated on plans, extension box and valve key.

2.3 BALL VALVES - 2 Inches and Smaller

- A. Manufacturers:
Mueller Oriseal or approved equal.
- B. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.

2.4 BUTTERFLY VALVES - From 2 inches to 24 inches

ANSI/AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.

2.5 Check valves, post indicator valves and backflow preventors - Refer to Section 15300 (Fire Protection) in the Architectural/Building Specifications

2.6 HYDRANT

- A. Hydrant: Type as required by utility company and as shown on plans.
- B. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.
- C. Hose and Steamer Connection: Match sizes with utility company, two hose nozzles, one pumper nozzle.
- D. Finish: Primer and two coats of enamel or special coating to as color as required by utility company.

2.07 ACCESSORIES

- A. Concrete for Thrust Blocks: Place thrust blocking consisting of 2,500 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil without loading undisturbed soil in excess of 2,500 lbs/sq ft when water main pressure is 100 psi.

MINIMUM THRUST BLOCKING BEARING AREAS

| Pipe Diameter | Tees Sq. Ft. | 90° Bend Sq. Ft. | 45 ° Bend Sq. Ft. | 22 1/2 ° Bend Sq. Ft. | 11 1/4 ° Bend Sq. Ft. |
|---------------|-----------------|---------------------|----------------------|--------------------------|--------------------------|
| 3" | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 4" | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| 6" | 1.5 | 2.0 | 1.0 | 1.0 | 1.0 |
| 8" | 2.5 | 3.5 | 1.8 | 1.0 | 1.0 |
| 10" | 4.0 | 5.5 | 2.8 | 1.5 | 1.0 |
| 12" | 6.0 | 8.0 | 4.0 | 2.0 | 1.5 |
| 14" | 8.0 | 11.0 | 5.5 | 3.0 | 2.0 |
| 16" | 10.0 | 14.2 | 7.0 | 4.0 | 3.0 |
| 18" | 21.0 | 21.0 | 12.0 | 6.0 | 4.0 |

- B. Locked Mechanical Joint fittings shall be installed where vertical changes in direction are required and, if approved by the Owner and governing authority, can be installed in lieu of the above thrust blocking requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions.
- B. Verify that building service connection and municipal utility water main size, location and depth are as indicated.

3.2 PREPARATION

- A. Ream pipe and tube ends and remove burr.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare pipe for connections to equipment with flanges or unions.

3.3 BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 02222 for work of this Section.

3.4 INSTALLATION - PIPE AND FITTINGS

- A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local code.
- B. Install pipe and fittings in accordance with ANSI/AWWA C600.
- C. Install pipe to allow for expansion and contraction without stressing pipe or joints or as specified by pipe manufacturer.
- D. Install access fittings in accordance with local codes to permit disinfection of water system performed under this Section.
- E. Connections with Existing Pipelines: Where connections are made between new work and existing piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions which least interfere with operation of existing pipeline and in compliance with the local utility company.
- F. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
- G. Establish elevations of buried piping in accordance with Section 02222 for work in this Section.
- H. Backfill trench in accordance with Section 02222.

3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Install gate valves as indicated on Drawings and supported on concrete pads with valve stem vertical and plumb. Install valve boxes in a manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely fit valve box together leaving cover flush with finished surface.
- B. Install fire hydrant assemblies as indicated on Drawings in vertical and plum position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to a street, roadway or parking lot drive or toward the protected building unless otherwise directed by local authorities. Support hydrant assembly on concrete pad and firmly braced on side opposite inlet pipe against undisturbed soil and concrete blocking. Place minimum of 6 cu. ft. of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Exercise care when backfilling and compacting so proper vertical position will not be altered.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

Disinfect distribution system with chlorine before acceptance for domestic operation. Amount of chlorine shall be such as to provide dosage of not less than 50 parts/million. Thoroughly flush lines before introduction of chlorinating materials and after contact period of not less than 24 hours, system shall be flushed with clean water until residual chlorine content is not greater than 1.0 part/million. Open and close valves in lines being disinfected several times during contact period. After disinfection, take water sample and bacteriologically test in accordance with AWWA specifications. Do not place distribution system in service until approval is obtained from applicable governing authorities.

3.7 SERVICE CONNECTIONS

Provide water service connection in compliance with utility company requirements including reduced pressure backflow prevented if required and water meter with by-pass valves and sand strainer.

3.8 FIELD QUALITY CONTROL

- A. Compaction testing of trench backfill shall be performed in accordance with Section 02222.
- B. Water distribution system pipe installed below grade and outside building shall be tested in accordance with following procedures:
 - 1. The Contractor shall perform the testing of pipe materials, joints, and/or other materials incorporated into the construction of water mains and force mains to determine leakage and watertightness. All pressure pipeline shall be tested in accordance with Section 4 of AWWA C600-82. In the event any state or local code requires a more stringent test, the more stringent shall apply.
 - 2. Pressure Test:
After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1.5 times the working pressure at the point of testing and not less than 1.25 times the working pressure at the highest point along the test section.
 - 3. Leakage Test:
The leakage test shall be conducted concurrently with the pressure test. Leakage is defined as the quantity of water that must be supplied into the newly laid pipeline, or any valved section thereof,

to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipeline has been filled with water. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

No pipeline installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{SDP}{133200}$$

$$133200$$

L = allowable leakage, (gallons per hour)

S = length of pipe tested, (feet)

D = nominal diameter of pipe, (inches)

P = average test pressure during test, (psig)

4. Visible Leakage:
All visible leaks shall be repaired regardless of the amount of leakage.
5. Acceptance of Installation:
If any test of pipe laid in place discloses leakage greater than that specified, the Contractor shall, at his own expense, locate the leak and make repairs as necessary until the leakage is within the specified allowance.
Contractor shall supply all water for testing at no expense to the Owner.
6. Contractor shall furnish one copy of results of meter test and hydrostatic pressure test to the Owner and utility company upon completion of water distribution backfilling operations.

END SECTION # 33 11 00

SECTION 33 21 00 - SITE GAS LINES

PART I GENERAL

1.1 SECTION INCLUDES

- A. Pipe and fittings for site utility natural or propane gas distribution.
- B. Propane storage tanks.

1.2 RELATED SECTIONS

- A. Section 31 14 00 - Earthwork
- B. Section 31 23 00 - Excavating, Backfill, and Compacting for Utilities
- C. Construction Drawings

1.03 REFERENCES

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop.
- B. ANSI/ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ANSI/ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
- E. ANSI/ASME Sec. 8D - Pressure Vessels.
- F. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
- G. ANSI/ASTM B32 - Solder Metal
- H. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- I. ANSI/AWS A5.8 - Brazing Filler Metal.
- J. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other liquids.
- K. ANSI B16.3 - Malleable Iron Threaded Fittings.
- L. ANSI B16.11 - Forged Steel Fittings, Socket Welding and Threaded.
- M. ANSI B31.2 - Fuel Gas Piping.
- N. ANSI B31.8 - Gas Transmission and Distribution Piping Systems.
- O. ANSI Z223.1 (NFPA 54) - National Fuel Gas Code.
- P. ASME Boiler and Pressure Code.
- Q. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated (Galvanized) Welded and Seamless, for ordinary Uses.
- R. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- S. ASTM B75 - Seamless Copper Tube.
- T. ASTM B88 - Seamless Copper Water Tube.
- U. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
- V. ASTM D2517 - Reinforced Epoxy Resin Gas Pressure Pipe and Fittings.
- W. ASTM D2683 - Socket Type Polyethylene Fittings For Outside Diameter Controlled Polyethylene Pipe and Tubing.
- X. ASTM D2922 - Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
- Y. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
- Z. ASTM F678 - Polyethylene Gas Pressure Pipe, Tubing and Fittings.

1.4 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.

1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of pipe mains, valves, connections, and top of pipe elevations.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with utility company and/or municipality.
- B. Gas Cock: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME Boiler and Pressure Vessel Code and applicable state regulations.
- D. Welders Certification: In accordance with ANSI/ASMIE Sec 9.
- E. Conform to ANSI Z223.1 (NFPA 54) ANSI B31.2 and/or ANSI B31-8.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle all products to be included in the work.
- B. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 PIPE

- A. Steel Pipe Below Ground: ASTM A120, Schedule 40 black:
 - 1. Fittings: ANSI B16.11, forged steel, or ASTM A234 forged steel welding type.
 - 2. Joints: Welded and seamless.
 - 3. Jackets: ANSI/AWWA C105 polyethylene jacket, Double layer, half lapped, 10 mil polyethylene tape.
- B. Steel Pipe Above Ground: ASTM A120 Schedule 40 black:
 - 1. Fittings: ANSI B16.3, malleable iron, ANSI B16.11, forged steel, or ASTM A234, forged steel welding type.
 - 2. Joints: Threaded.
- C. For Propane Systems: Copper tubing below ground: ASTM B88, Type K, internally tinned:
 - 1. Fittings: ANSI/AWWA B16.18, cast copper, or ANSI/ASME B16.22, wrought copper; internally tinned.
 - 2. Joint: ANSI/AWS A5.8 BCUP silver brazed.
- D. For Propane Systems: Copper tubing above ground: ASTM B88, Type K, L or ASTM B75, Type GP; internally tinned:
 - 1. Fittings: ANSI/ASME B6.18 cast copper, ANSI/ASME B16.22, wrought copper, or ANSI/ASME B16.26, cast copper, internally tinned.
 - 2. Joint: ANSI/ASTM B32, Solder, Grade 95TA or AMSI/AWS A5.8, BCUP silver brazed.
- E. Polyethylene Pipe: ASTM D2513, SDR 11.5 or ASTM F678 Series 125:
 - 1. Fittings: ASTM D2513.
 - 2. Joints: Mechanical or Compression fit.
 - 3. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Natural Gas Service" in large letters.
- F. Reinforced Epoxy Resin Piping: ASTM D2517:
 - 1. Fittings: ASTM D2517.
 - 2. Joints: Bell and spigot with epoxy resin.
 - 3. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Natural Gas Service" in large letters.

2.2 GAS COCKS

- A. 2 Inches and Smaller: 150 psig (1 040 kPa) WOG, bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends with cast iron curb box, cover, and key.
- B. 2 Inches and Larger: 125 psig (860 kPa) WOG, Steel or Cast iron body and tapered plug, non-lubricated, Teflon packing, threaded ends, with cast iron curb box, cover, and key.
- C. For Applications With Line Pressure Greater Than 60 psig (415 KPA): Over 2 Inches (50 mm) : Cast iron body and plug, pressure lubricated, Teflon packing, flanged ends, with cast iron curb box, cover, and key.

2.3 PRESSURE REGULATING VALVES

- A. Valves: Single stage, malleable iron body, corrosion- resistant, pressure regulator with atmospheric vent, elevation compensator; with threaded ends for 2 inch and smaller, flanged ends larger than 2 inch.
- B. Capacity: For inlet and outlet gas pressures, specific gravity, and flow rate indicated.

2.4 PROPANE STORAGE TANKS

- A. Construction: Closed, welded steel, tested and stamped in accordance with ANSI/ASME Section 8D; minimum 250 psig (1 700 kPa) rating; cleaned, prime coated and painted with two coats of silver anti-rust paint, and supplied with steel support saddles, pressure gage; tapping for installation of piping and accessories.
- B. Vaporizer: 1,000 watts, heating cable bedded in 1 inch of glass fiber insulation and covered by flexible stainless steel plate, with thermostat in weatherproof box set to turn on at -13 degrees F with manual off -on switch.
- C. Size:
 - 1. Capacity: Diameter and length as shown on plans.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions.
- B. Verify that building service connection and utility gas main size, location and depth are as indicated.

3.2 PREPARATION

- A. Ream pipe ends and remove burrs. Bevel plain end ferrous pipe over 2 inches diameter Thread ferrous pipe 2 inches diameter and under.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections with flanges or threading and unions.

3.3 BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 31 14 00 for work of this Section.

3.4 INSTALLATION – PIPING

- A. Maintain separation of gas line from sewer, water or storm water piping in accordance with state or local code.
- B. Install piping to conserve space and not interfere with use of site space.
- C. Install piping to allow for expansion and contraction without stressing pipe or joints.
- D. Install cocks and other fittings as required.
- E. Establish elevations of buried piping in accordance with Section 31 14 00 or work in this Section.
- F. Wrap couplings and fittings of steel pipe with polyethylene tape and heat shrink over pipe.
- G. For nonmetallic Pipe: Install trace wire continuous over top of pipe.
- H. Backfill trench in accordance with Section 31 14 00.
- I. Center and plumb valve box over valve. Set box cover flush with finished ground surface. Prevent shock or stress from being transmitted through valve box to valve.
- J. Wrap valve and valve box with polyethylene tape and heat shrink or paint valves and valve boxes with red anti-rust primer and one coat of epoxy paint.

3.5 SERVICE CONNECTIONS

- A. Provide sleeve in foundation wall for gas service main. Caulk enlarged sleeve watertight.
- B. Anchor service main to interior surface of foundation wall.
- C. Install service regulator adjacent to building wall in specified location.

- D. Install service regulator and riser pipe to prevent undue stress upon service pipe. For plastic service pipe, use steel pipe riser from below ground to regulator.
- E. Provide regulator vent with rain and insect proof opening, terminating not less than five feet away from building openings.

3.6 PROPANE TANK INSTALLATION

- A. Place tank legs on concrete footings, level within tolerance of 2 inches. Provide footings in accordance with Section 03300.
- B. Prepare and grade an area outside tank perimeter, for a distance of 6 feet. Grade, place and compact gravel fill to a compacted depth of 3 inches. Compact to 95 percent.
- C. Provide tank with relief valve, shutoff valve, pressure regulator, pressure gage and removable protection cover. Install piping, shutoff valve and pressure gage to underground piping.
- D. Set tank regulator to outlet pressure as indicated on plans.
- E. Install vaporizer to under side of tank and secure to tank with aluminum tray and two stainless steel straps.
- F. Install weatherproof control box for vaporizer 40 inches above ground surface. Install to 4 x 4 inch cedar post, driven into ground 40 inches.
- G. Install wiring. Install control wire from vaporizer to control box 20 inches below ground surface. Install service wiring 24 inches below ground from control box to building.

END OF SECTION # 33 21 00

SECTION 33 31 00 - SANITARY SEWER SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

Furnish labor, materials, services, equipment, and other necessary items required for accompanying the construction of the sanitary sewer systems. This shall include, but not be limited to, the following:
Sanitary sewer drainage piping, Fittings and Accessories, Cleanouts, and Bedding.
Set lines, elevations, and grades for sanitary sewer system work and control system for duration of work, including careful maintenance of benchmarks, property corners, monuments, or other reference points.

1.2 RELATED REQUIREMENTS

- A. Construction Drawings
- B. Specifications Section 31 23 00 Excavation, Backfilling, and Compacting for Utilities
- C. Specifications Section 33 39 00 Sewer Structures
- D. Local governing authority and code requirements
- E. All necessary construction permits

1.3 REFERENCES

- A. ANSI/ASTM A74 - Cast Iron Soil Pipe and Fittings.
- B. ANSI/ASTM C12 - Practice for Installing Vitrified Clay Pipe Lines.
- C. ANSI/ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- D. ANSI/ASTM C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- E. ANSI/ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings.
- F. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- G. ANSI/ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 Kg) Rammer and 12 inch (304.8 mm) Drop.
- H. ANSI/ASTM D3034 - Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
- I. ASTM A746 - Ductile Iron Gravity Sewer Pipe.
- J. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings,
- K. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength and perforated.
- L. ASTM D1785 - Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- M. ASTM D2922 - Test Methods for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth).
- N. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

1.4 DEFINITION

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 SUBMITTALS

- A. Product Data: Provide catalog materials indicating pipe, pipe accessories, and fittings.
- B. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- C. Manufacturer's Certificate: Certify that products meet or exceed ASTM designations.

1.6 COORDINATION

- A. Coordinate the Work with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

PART 2

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Polyvinyl Chloride Sanitary Sewer
 - 1. Pipe and fittings shall comply with ASTM D 3034, rated SDR 35 unless otherwise specified by the local utility. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification.
 - 2. Pipe joints shall be integrally molded bell ends per ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.
 - 3. Corrugated Polyvinyl Chloride sewer pipe and fittings shall comply with ASTM F 949. Pipe must be marked with manufacturers name, pipe size, cell classification and ASTM F 949 Classification. Pipe must be installed per the manufacturer's installation requirements. Acceptable manufacturer: CON'RECH, INC. "A-2000" PVC sewer pipe or Owner-approved equivalent.
- B. Corrugated Polyethylene (CPP) Sanitary Sewer
 - 1. Pipe shall be smooth interior, available in sizes 4" thru 18" and shall comply with AASHTO designation #M294 and/or #M252.
 - 2. Pipe fittings shall be thermo-molded PVC conforming to ASTM D 3034, rated SDR 35.
 - 3. Gasket material used with the thermo-molded PVC fittings and the CPP pipe joint assembly shall conform to ASTM F-477.
- C. Vitrified Clay Sanitary Sewer
 - 1. Sanitary Sewer Pipe and Fittings: Vitrified clay pipe meeting or exceeding requirements of ASTM C 700.
 - 2. Joints: ASTM C 425 specifications for "Compression Joints for Vitrified Clay Pipe and Fittings."
 - 3. Gaskets: ASTM C 425 specification for "Compression Joints for Vitrified Clay Pipe and Fittings". Gaskets shall be manufactured from high grade, properly vulcanized elastomeric compound consisting of either basic natural or synthetic rubber. Gasket manufacturing tolerances shall comply with Rubber Manufacturer's Association tolerances for gaskets.
 - 4. Lubricant: Suitable for lubricating joint components; no deteriorating effects on gasket or pipe material, will not support growth of fungi or bacteria, and shall be of type recommended by gasket manufacturer.
- D. Ductile Iron Sanitary Sewer
 - 1. Ductile Pipe: ASTM A746, Extra Heavy type, inside nominal diameter as specified on plans, bell and spigot end.
 - 2. Ductile Iron Pipe Joint Device: ANSI A21.11, rubber gasket joint devices.
- E. Cast Iron Sanitary Sewer
 - 1. Cast Iron Soil Pipe: ANSI/AS7M A74, Extra Heavy type, inside nominal diameter of as specified on plans, bell and spigot end.
 - 2. Cast Iron Pipe Joint Device: ASTM C564, rubber gasket joint devices.
- F. Concrete Sanitary Sewer
 - 1. Concrete Pipe: ANSI/ASTM C14, Class 1, 2, or 3 bell and spigot pipe with inside nominal diameter as specified on plans.
 - 2. Concrete Pipe Joint Devices: ANSI/ASTM C443, rubber compression gasket joint devices.
- G. Reinforced Concrete Sanitary Sewer
 - 1. Reinforced Concrete Pipe: ANSI/ASTM C76, Class I, II, III, IV, or V as specified on plans, with Wall type A, B, or C; mesh reinforcement; inside nominal diameter as specified, bell and spigot end.
 - 2. Reinforced Concrete Pipe Joint Device: ANSI/ASTM C443, rubber compression gasket joint devices.

2.2 PIPE ACCESSORIES

- A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.3 CLEANOUTS

- A. Lid and Frame: Heavy Duty cast iron construction, manufactured by Mueller Lid Design: Closed Lid.
- B. Shaft Construction: Cast Iron shaft of internal diameter as specified on plans with 2500 psi concrete collar for cleanouts.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on civil engineering drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 31 14 00 for work of this Section.

3.4 INSTALLATION – PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM C12, ASTM C14 and/or manufacturer's instructions and state or local requirements.
- B. Lay pipe to slope gradients noted on civil engineering drawings.
- C. Install pipe on bedding in accordance with Section 31 14 00 for work in this Section.
- D. Refer to Section 31 14 00 for trenching requirements. Do not displace or damage pipe when compacting.
- E. Refer to Section 33 39 00 for manhole requirements.
- F. Connect to building sanitary sewer outlet and municipal sewer system as indicated on the drawings.

3.5 INSTALLATION – CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe to be installed to proper elevations.

3.6 FIELD QUALITY CONTROL

- A. Compaction testing will be performed in accordance with ANSI/ASTM D698, ASTM D2922 or ASTM D3017.
- B. Test sanitary sewer pipe system installed below grade and outside building in accordance with the following procedures:
 - 1. The Contractor shall perform the testing of manhole construction, pipe materials, joints and/or other materials incorporated into the construction of the sanitary sewer system to determine leakage and watertightness. In the event any state or local code requires a more stringent test, the more stringent shall apply.
 - 2. Manhole Testing:
The Owner and/or Governing Agency shall determine the method of manhole testing set forth below. The test method selected will be determined by the depth of each manhole, groundwater level, concrete honeycombing, or other conditions which make the selected test suitable for determining the physical condition and watertightness of the manhole.
 - 2.1 Manhole Exfiltration Testing:
All incoming and outgoing sewer lines shall be plugged the manhole filled with water up to the top of the poured concrete or above the highest precast barrel joint. If the water loss exceeds the maximum allowable as shown below; the manhole shall have failed the test.

| Depth of Manhole | Maximum Allowable Water Loss |
|---------------------|---|
| 0-8 feet | 1 inch over 5 minutes |
| greater than 8 feet | 1/8 gallon per vertical foot over 5 minutes |

- 2.2 Manhole Vacuum Testing:
The manhole vacuum test shall be performed with suitable apparatus made for such purpose and shall draw a vacuum of 10 inches of Mercury (Hg). The test shall pass if the

vacuum remains at 10" of Mercury (Hg) or drops to not less than 9" of Mercury (Hg) in one minute.

3. Flexible Pipe Deflection Testing:

3.1 Allowable Deflection:

The maximum allowable pipe deflection shall not exceed **(5)** five percent of the nominal inside diameter.

3.2 Mandrel:

The mandrel (go/no-go) device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with less arms will be rejected as not sufficiently accurate. The contact length of the mandrel's arms shall equal or exceed the nominal inside diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance of plus or minus 0.01 inch. The mandrell and all necessary equipment for the mandrell test shall be provided by the Contractor.

3.3 Procedure:

The mandrel shall be hand-pulled by the contractor through all flexible pipe sewer lines no earlier than 30 days after the trench has been completely backfilled. Any sections of the sewer not passing the mandrel shall be uncovered and the Contractor shall rebed, reround, or replace the sewer to the satisfaction of the Owner and/or Governing Agency. Any repaired section shall be retested.

3.4 Mandrell O.D. (outside diameter):

The outside diameter of the mandrell shall be set according to the following table:

| NOMINAL DIAMETER (IN.) | MANDRELL O.D. (IN.) |
|------------------------|---------------------|
| 6" | 5.40 |
| 8" | 7.12 |
| 10" | 8.87 |
| 12" | 10.55 |
| 15" | 12.89 |
| 18" | 15.30 |

3.5 Contractor's Warranty:

The Owner and/or Governing Agency reserves the right to mandrell test any flexible pipe sewer line before acceptance, and also prior to expiration of the first year of operation. If a previously accepted line fails a mandrell test performed during the first year of operation, the defects must be corrected at the Contractor's expense.

4. Air Testing of Gravity Sewers:

4.1 Procedure:

- 4.1.1 Plug all pipe outlets with suitable test plugs. Brace each plug securely.
- 4.1.2 Pipe air supply to the pipeline to be tested in such a manner that the air supply may be shut off, pressure observed, and air pressure released from the pipe without workmen entering the manhole.
- 4.1.3 Add air slowly to the portion of pipe under test until the internal pressure of the line is raised to approximately 4 psig, but less than 5 psig.
- 4.1.4 Shut the air supply off and allow at least two minutes for the air pressure to stabilize
- 4.1.5 When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi, start the test.
- 4.1.6 Determine the time in seconds with a stopwatch for the pressure to fall 0.5 psig so that the pressure at the end of the time is at or above 3.0 psig.

- 4.1.7 Compare the observed time with the minimum allowable times in the chart below for pass/fail determination.

| 1 Pipe Diameter (in.) | 2 Minimum Time (min: sec.) | 3 Length for Minimum Time (ft.) | 4 Time for Longer Length (sec.) | SPECIFICATION TIME FOR LENGTH (L) SHOWN (MIN:SEC) | | | | | | | |
|--------------------------------|--|--|--|---|--------|--------|--------|--------|--------|--------|--------|
| | | | | 100 ft | 150 ft | 200 ft | 250 ft | 300 ft | 350 ft | 400 ft | 450 ft |
| 4 | 1:53 | 597 | .190L | 1:53 | 1:53 | 1:53 | 1:53 | 1:53 | 1:53 | 1:53 | 1:53 |
| 6 | 2:50 | 398 | .427L | 2:50 | 2:50 | 2:50 | 2:50 | 2:50 | 2:50 | 2:51 | 3:12 |
| 8 | 3:47 | 298 | .760L | 3:47 | 3:47 | 3:47 | 3:47 | 3:48 | 4:26 | 5:04 | 5:42 |
| 10 | 4:43 | 239 | 1.187L | 4:43 | 4:43 | 4:43 | 4:57 | 5:56 | 6:55 | 7:54 | 8:54 |
| 12 | 5:40 | 199 | 1.709L | 5:40 | 5:40 | 5:42 | 7:08 | 8:33 | 9:58 | 11:24 | 12:50 |
| 15 | 7:05 | 159 | 2.671L | 7:05 | 7:05 | 8:54 | 11:08 | 13:21 | 15:35 | 17:48 | 20:02 |
| 18 | 8:30 | 133 | 3.846L | 8:30 | 9:37 | 12:49 | 16:01 | 19:14 | 22:26 | 25:38 | 28:51 |
| 21 | 9:55 | 114 | 5.235L | 9:55 | 13:05 | 17:27 | 21:49 | 26:11 | 30:32 | 34:54 | 39:16 |
| 24 | 11:20 | 99 | 6.837L | 11:24 | 17:57 | 22:48 | 28:30 | 34:11 | 39:53 | 45:35 | 51:17 |
| 27 | 12:45 | 88 | 8.653L | 14:25 | 21:38 | 28:51 | 36:04 | 43:16 | 50:30 | 57:42 | 64:54 |
| 30 | 14:10 | 50 | 10.683L | 17:48 | 26:43 | 35:37 | 44:31 | 53:25 | 62:19 | 71:13 | 80:07 |
| 33 | 15:35 | 72 | 12.926L | 21:33 | 32:19 | 43:56 | 53:52 | 64:38 | 75:24 | 86:10 | 96:57 |
| 36 | 17:00 | 66 | 15.384L | 25:39 | 38:28 | 51:17 | 64:06 | 76:55 | 89:44 | 102:34 | 115:23 |

- 4.2 Safety Precautions:
The low pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is over pressurized or plugs are installed improperly. It is extremely important that the various plugs be installed so as to prevent the sudden expulsion of a poorly inflated plug. As an example of the hazard, a force of 250 pounds; exerted on an 8 inch plug by an internal pressure of 5 psi. Observe the following safety precautions:
- 4.2.1 No person shall be allowed in the manholes during the test or when a plugged pipe is under pressure.
- 4.2.2 Gauges, air piping manifolds, and valves, shall be located at the top of the ground.
- 4.2.3 Install and brace all plugs securely.
- 4.2.4 Do not over pressurize the lines.
- 4.3 Ground Water Elevation:
If the pipeline to be tested is below the ground water level, the starting test pressure shall be increased by 0.433 psi for each foot the groundwater level is above the invert of the sewer pipe. In no case shall the starting test pressure exceed 9.0 psig.
- 4.4 Acceptance of Installation:
No gravity sewer or manhole will be accepted that does not comply with the minimum requirements of tests described in this specification.
- 4.5 Test Equipment:
All necessary equipment to perform the air test in accordance with this specification shall be provided by the contractor. The test gauge shall preferably have incremental division of 0.10 psi and have an accuracy of at least plus or minus 0.04 psi. In no case shall a test gauge be used which has incremental divisions of greater than 0.25 psi. The gauge shall be of sufficient size in order to determine this accuracy.
- 4.6 Contractor shall furnish one copy of gravity sewer and manhole test results to the Owner and Governing Agency upon completion of gravity sewer system backfilling operations.

END OF SECTION # 33 31 00

SECTION 33 39 00 - SEWER STRUCTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Monolithic concrete manhole barrel with the option of monolithic concrete or masonry transition to lid frame, covers, anchorage and accessories.
- B. Modular pre-cast concrete manhole barrel with tongue-and-groove joints and with the option of pre-cast concrete or masonry transition to lid frame, covers, anchorage and accessories.
- C. Masonry manhole barrel with masonry transition to lid frame, covers, anchorage and accessories.
- D. Pre-cast Polyethylene manhole assemblies.

1.2 RELATED SECTIONS

- A. Section 31 23 00 - Excavation, Backfill, and Compacting for Utilities
- B. Section 33 41 00 - Storm Sewer Systems
- C. Section 33 31 00 - Sanitary Sewer Systems
- D. Construction Drawings

1.3 REFERENCES

- A. ANSI/AS7M C55 - Concrete Building Brick.
- B. ASTM A48 - Gray Iron Castings.
- C. ASTM C478 - Pre-cast Reinforced Concrete Manhole Sections.
- D. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
- E. AS7M D1248 - Pre-cast Polyethylene Manholes.
- F. International Masonry Industry All-Weather Council (IMIAC): Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate reference to drawings of manhole locations, elevations, piping with sizes, locations and elevations of penetrations.
- B. Product Data: Provide data for manhole covers, manhole steps, component construction, features, configuration, and dimensions.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Manhole Barrel: Reinforced pre-cast concrete, in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
 - 1. Construct manholes of pre-cast concrete sections as required by Drawings to size, shape, and depth indicated, but never less than 4'-0" inside diameter.
- B. Manhole Barrel: Non-reinforced cast-in-place concrete.
 - 1. Cast-in place Manholes shall be constructed of 3500 psi concrete.
 - 2. Forms shall be made of steel sheets accurately shaped and fabricated of sufficient strength to form dense watertight walls to true dimensions.
 - 3. Concrete shall be deposited in evenly distributed layers of about 18 inches, with each layer vibrated to bond it to the preceding layer.
- C. Fiberglass Manholes:
Fiberglass Wetwell:
General: Fiberglass reinforced polyester wetwells shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resin, with fiberglass reinforcements.
Materials:
Resins: The resins used shall be a commercial grade unsaturated polyester resin.
Reinforcing Materials: The reinforcing materials shall be commercial Grade "E" type glass in the form of mat, continuous roving, chopped roving, roving fabric, or a combination of the above,

having a coupling agent that will provide a suitable bond between the glass reinforcement and the resin.

Surfacing Materials: If reinforcing materials is used on the surface exposed to the contained substance, it shall be a commercial grade chemical-resistant glass that will provide a suitable bond with the resin and leave a resin rich surface.

Fillers and Additives: Fillers, when used, shall be inert to the environment and wetwell construction. Additives, such as thixotropic agents, catalysts, promoters, etc. may be added as required by the specific manufacturing process to be used. The resulting reinforced plastic material must meet the requirement of this specification.

Fabrication:

Exterior Surface: The exterior surface shall be relatively smooth with no sharp projections. Hand-work finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than ½ inch in diameter, delamination and fiber show.

Interior Surface: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of crazing, delamination, blisters larger than ½ inch in diameter, and wrinkles of 1/8 inch or greater in depth. Surface pits shall be permitted up to 6/square feet if they are less than ¾ inch in diameter and less than 1/16 inch deep.

Defects not Permitted:

- a. Exposed fibers: glass fibers not wet out with resin.
- b. Resin runs: Runs of resin and sand on the surface.
- c. Dry areas: Areas with glass not wet out with resin.
- d. Delamination: Separation in the laminate.
- e. Blisters: Light colored areas larger than ½ inch in diameter.
- f. Crazing: Cracks caused by sharp objects.
- g. Pits or Voids: Air pockets
- h. Wrinkles: Smooth irregularities in the surface.
- i. Sharp Projection: Fiber or resin projections necessitating gloves for handling.

Physical Requirements:

Load Rating: The complete wetwell shall have a minimum dynamic-load rating of 16,000 ft-lbs when tested in accordance with Testing Methods. To establish this rating, the complete wetwell shall not leak, crack, or suffer other damage when load tested to 40,000 ft-lbs and shall not deflect vertically downward more than ¼ inch at the point of load application when loaded to 24,000 lbs.

Stiffness: The wetwell cylinder shall have a minimum pipe-stiffness values shown in the table below:

| Stiffness Requirements | |
|------------------------|-----------|
| Length, ft. | F/AY, psi |
| 10 to 20 | 2.01 |
| 21 to 30 | 3.02 |
| 31 to 40 | 5.24 |

Physical Properties:

| | Hoop Direction | Axial Direction |
|----------------------------|-----------------------|-----------------------|
| a. Tensile Strength (psi) | 18,000 | 5,000 |
| b. Tensile Modulus (psi) | 0.8 x 10 ⁶ | 0.7 x 10 ⁶ |
| c. Flexural Strength (psi) | 26,000 | 4,500 |
| d. Flexural Modulus (psi) | | |
| (no ribs – 48", 60", 72") | 1.4 x 10 ⁶ | 0.7 x 10 ⁶ |
| (with ribs – 96", 144") | 0.7 x 10 ⁶ | 0.7 x 10 ⁶ |

Test Methods: Test shall be performed as specified in ASTM D 3753 latest edition.

Required Thicknesses for Buried Fiberglass Manholes

Fiberglass manholes shall meet the following thickness requirements:

| Diameter (in) | Wet Soil Depth (max) (ft) | Min. Thickness (in) | Min. Thickness Allowed |
|------------------|------------------------------|------------------------|---------------------------|
|------------------|------------------------------|------------------------|---------------------------|

| | | | |
|----|----|-------|-------|
| 48 | 10 | .25 | .375 |
| | 20 | .3125 | .375 |
| | 30 | .375 | .375 |
| 60 | 10 | .375 | .375 |
| | 20 | .4375 | .4375 |
| | 30 | .5 | .5000 |

Installation:

Fiberglass manholes will be confined to installations behind the curb, or out of heavy traffic lanes only. Further, the fiberglass manhole shall not be used for depths greater than ten (10) feet. The manholes shall be installed according to the manhole details shown in the plans. After the manhole has been installed into the concrete base as shown, the excavated area will be backfilled with sand.

- D. Manhole Barrel: Pre-cast Polyethylene in accordance with ASTM D 1248. Manholes shall be manufactured with factory-molded steps. The nominal cylinder internal diameter shall be 4811 and shall be designed to accept concrete filled polyethylene manhole lids and standard cast iron frames with lid or grate. Manholes shall have compressive strength which meets ASTM D 2412 standards. Acceptable Manufacturers: Advanced Drainage Systems (ADS) or Owner-Approved equivalent manufacturer.
- E. Concrete Brick Units: ANSI/ASTM C55, Grade N Type I- Moisture Controlled, normal weight, of same Grade, Type and weight as block units, nominal modular size of 3 5/8 x 7 5/8 x 2 1/4 inches.
- F. Mortar and Grout: Mortar for finishing and sealing shall be Class "C". Honeycombing less than two (2) inches deep shall be repaired using Class "D" mortar.
- G. Brick Transition Reinforcement: Formed steel 8 gage wire with galvanized finish.

2.2 COMPONENTS

- A. Lid and Frame: ASTM A48, Class 30B Heavy Duty Cast iron construction, machined flat bearing surface, removable lid, closed or open as specified on plans; sealing gasket; manufactured by Neenah Foundry Company or approved equal.
- B. Manhole Steps: Neenah Foundry Company catalog No. R- 1982-F for pre-cast or catalog No. R- 1980-0 for brick/cast-in-place manholes or M.A. Industries PS-1 or approved equal.
- C. Base Pad: Cast-in-place concrete.

2.3 CONFIGURATION

- A. Barrel Construction: Concentric with eccentric cone top section.
- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: 48 inch diameter or as indicated on plans.
- D. Design Depth: As indicated on plans.
- E. Clear Lid Opening: 22 inches minimum.
- F. Pipe Entry: Provide openings as indicated on plans.
- G. Main and Lateral Pipes: Neatly cut off main and lateral pipes flush with inside of manhole or inlet where they enter structure walls, and point up irregularities and rough edges with non-shrinking grout.
- H. Inverts: Shape inverts for smooth flow across structure floor as shown on Drawings. Use concrete and mortar to obtain proper grade and contour and finish surface with fine textured wood float.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into work.
- C. Verify excavation for manholes is correct.

3.2 PREPARATION

Coordinate placement of inlet and outlet pipe or duct sleeves as indicated on plans.

3.3 PLACING PRE-CAST MANHOLE BARREL SECTIONS

- A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
- B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
 - 1. After completion of slab foundation the first joint of manhole barrel shall be lowered into position, grooved end first and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert which shall be poured immediately after setting of first section of manhole barrel.
 - 2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.

3.4 MASONRY MANHOLE BARREL CONSTRUCTION

- A. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- B. Lay masonry units in running bond. Course 3 brick units and 3 mortar joints to equal 8 inches.
- C. Form flush mortar joints.
- D. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- E. Install joint reinforcement 16 inches o.c.
- F. Place joint reinforcement in first and second horizontal joints above base pad and below lid frame opening.
- G. As work progresses, build-in fabricated metal items.
- H. Cut and fit masonry for pipes in accordance with 2.03-6 of this Section.
- I. Set cover frames and covers level without tipping, to correct elevations.

END OF SECTION 33 39 00

SECTION 33 41 00 - STORM SEWER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Site storm sewerage drainage piping, fittings and accessories, and bedding.
- B. Connection of building storm water drainage system to municipal sewers.
- C. Catch basins, paved area drainage, site surface drainage, and stormwater detention facilities.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 00 - Excavation, Backfill, and Compacting for Utilities
- B. Section 31 35 00 - Slope Protection and Erosion Control
- C. Section 33 39 00 - Sewer Structures
- D. Section 33 31 00 - Sanitary Sewerage System
- E. Local governing authority and code requirements.
- F. All necessary construction permits.
- G. Construction Drawings

1.3 REFERENCES

- A. AASTHO M294 and M252 - Corrugated Polyethylene pipe smooth interior.
- B. AASHTO M36 - Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains.
- C. AASHTO T180 - Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop.
- D. ANSI/ASTM A74 - Cast Iron Soil Pipe and Fittings.
- E. ANSI/ASTM C12 - Practice for Installing Vitrified Clay Pipe Lines.
- F. ANSI/ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- G. ANSI/ASTM C76 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- H. ANSI/ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings.
- I. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- J. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- K. ANSI/ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
- L. ANSI/ASTM D3034 - Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
- M. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
- N. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- O. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

1.4 DEFINITIONS

Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.6 COORDINATION

Coordinate the Work with termination of storm sewer connection outside building including connection to municipal storm sewer system.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS AND ACCESSORIES

- A. Reinforced Concrete Pipe: Comply with requirements of ASTM C 76, Class III unless another class type is indicated on Drawings, installed with flexible plastic (Bitumen) gaskets at all joints. Gaskets shall comply with AASHTO M-198 751, Type B, and shall be installed in strict accordance with pipe manufacturer's recommendations.
- B. Corrugated Steel Pipe: Galvanized, aluminized or bituminous coated as specified on the drawings only permitted when specifically indicated on Drawings; and shall comply with requirements of ASTM A 760; 16 gage unless another gage is indicated on Drawings. Install with matching band connectors. Install sleeve gaskets in accordance with pipe manufacturer's recommendations. Corrugated steel pipe may be round pipe, arch pipe, or slotted drain pipe as indicated on Drawings. Slotted drain pipe shall have 1.75" wide drain guide waterway openings and 6" minimum height drain guide.
- C. Spiral Rib Metal Pipe Type 1R: Galvanized, aluminized or bituminous coated as specified on Drawings. Only permitted when specifically indicated on Drawings. Pipe ends shall be recorrugated and installed with semi-corrugated Hugger-type bands and "O" ring gaskets in accordance with pipe manufacturers installation requirements. Spiral Rib metal pipe must comply with ASTM A 760 Type 1R. Acceptable manufacturer: CONTECH, INC. "ULTRA FLO or ULTRA FLO II" and Caldwell Culvert Co. "Smooth Cor" or approved equal.
- D. Polyvinyl Chloride (PVC) Pipe: Only permitted when specifically indicated on Drawings. Pipe and fittings shall comply with ASTM D 3034, rated SDR 35. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification. Pipe joints shall be integrally molded bell ends in accordance with ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.
- E. Corrugated Polyethylene Pipe (CPP) Smooth Interior: Only permitted when specifically indicated on Drawings and shall conform with AASHTO Designation M294 and M252. Pipe must be installed in accordance with pipe manufacturers installation Guidelines for Culvert Storm Drainage Applications. Acceptable manufacturers: Advanced Drainage Systems, Inc. "ADS N-1211 & HANCOR, INC. "Hi-Q" or approved equal.
- F. Polyvinyl Chloride (PVC) large diameter closed profile gravity sewer pipe, UNL-B-9: Only permitted when specifically indicated on drawings. Pipe and fittings shall comply with ASTM F-794. Pipe must be installed in accordance with pipe manufacturers installation guidelines. Acceptable manufacturer: Carlon "Vylon H.C." or approved equal.
- G. Polyvinyl Chloride (PVC) 8" through 30" diameter, smooth interior, open profile gravity sewer pipe. Only permitted when specifically indicated on drawings. Pipe and fittings shall comply with ASTM F-794 and Uni-Bell Uni-B-9. Pipe must be installed in accordance with pipe manufacturers installation guidelines. Acceptable manufacturer: Extrusion Technologies, Inc. "Ultra-Rib" or approved equal.
- H. ADS HP Storm 12" – 60" Pipe: This specification describes the 12 – through 60 – inch (300 to 1500 mm) ADS HP Storm pipe for use in gravity-flow storm drainage applications.
- Pipe requirements:
- 12 – through 30-inch (300 to 750 mm) pipe shall have a smooth interior and annular exterior corrugations and meet to exceed ASTM F2736 and AASHTO M330.
 - 36 – through 60-inch (900 to 1500 mm) pipe shall have a smooth interior and annular exterior corrugations and meet or exceed ASTM F2881 and AASHTO M330.
 - Manning's "n" value for use in design shall be 0.012.

Joint Performance:

Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM F2736 or F2881, for the respective diameters.

12-through 60-inch (300 to 1500 mm) shall be watertight according to the requirements of ASTM D3212. Spigots shall have gaskets meeting the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during joint assembly.

12-through 60-inch (300 to 1500 mm) diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

Fittings:

Fittings shall conform to ASTM F2736, ASTM F2881 and AASHTO M330, for the respective diameters. Bell & spigot connections shall utilize a spun-on, welded or integral bell and a spigot with gaskets meeting ASTM F477. Bell & spigot fittings joint shall meet the watertight joint

performance requirements of ASTM D3212. Corrugated couplings shall be split collar, engaging at least 2 full corrugations.

Field Pipe and Joint Performance:

To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field testing any pipe material. Contact the manufacturer for recommended leakage rates.

Material Properties:

Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F2736, Section 4, ASTM F2881, Section 5 and AASHTO M330, Section 6.1 for the respective diameters.

Installation:

Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in traffic areas for 12 – through 48 – inch (300 to 1200 mm) diameters shall be one foot (0.3 m) and for 60 – inch (1500 mm) diameters, the minimum cover shall be 2 feet (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1, Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level. Contact your local ADS representative or visit our website at www.ads-pipe.com for a copy of the latest installation guidelines.

Pipe Dimensions:

| | | | | | | | | | |
|---|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| Nominal Diameter in. | 12 | 15 | 18 | 24 | 30 | 36 | 42 | 48 | 60 |
| (mm) | (300) | (375) | (450) | (600) | (750) | (900) | (1050) | (1200) | (1500) |
| Average Pipe I.D. in. | 12.1 | 14.9 | 18.0 | 24.1 | 30.1 | 35.7 | 41.8 | 47.3 | 59.3 |
| (mm) | (307) | (378) | (457) | (612) | (765) | (907) | (1062) | (1201) | (1506) |
| Average Pipe O.D. in. | 14.5 | 17.6 | 21.2 | 28.0 | 35.4 | 41.1 | 47.2 | 53.8 | 66.5 |
| (mm) | (368) | (447) | (538) | (711) | (899) | (1044) | (1199) | (1367) | (1689) |
| Minimum Pipe Stiffness at 5% | 75 | 60 | 56 | 50 | 46 | 40 | 35 | 35 | 30 |
| Deflection*#/in/in.(kN/m ²) | (520) | (411) | (385) | (343) | (320) | (275) | (240) | (240) | (205) |

2.2 INLETS, CATCH BASINS AND JUNCTION BOXES

- A. Lid and frame per details shown on plans.
- B. Structure construction in accordance with details shown on plans.

PART 3 EXECUTION

3.1 EXAMINATION

Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on civil engineering drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench and place bedding material in accordance with Section 02222 for work of this Section.

3.4 INSTALLATION – PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM C12, ASTM D2321 or manufacturer's instructions and state or local requirements.
- B. Install pipe on bedding in accordance with Section 31 23 00 for work in this Section.
- C. Lay pipe to slope gradients noted on construction drawings.

- D. Refer to Section 31 23 00 for trenching requirements. Do not displace or damage pipe when compacting.
- E. Refer to Section 33 39 00 for manhole requirements.

3.5 INSTALLATION - CATCH BASINS, INLETS AND JUNCTION BOXES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.
- C. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on the plans.
- D. Form and place cast-in-place top of structure in accordance with details shown on the plans.

END OF SECTION # 33 41 00