OFPC Project No. 903-1159

The University of Texas Rio Grande Valley

SCHOOL OF MEDICINE

TEAM BASED LEARNING CENTER

CONSTRUCTION DOCUMENTS

November 8, 2018

Volume 2: Division 22 thru Division 33

OFFICE OF FACILITIES PLANNING AND CONSTRUCTION
The University of Texas System
2102 Treasure Hills Boulevard, Suite 3.124
Harlingen, TX 78550
Phone: 956-296-1512

muñoz & company
Architects

PEREZ CONSULTING ENGINEERS
Civil Engineering

SSP DESIGN
Landscape Architect

INTELLIGENT ENGINEERING SERVICES
Structural Engineering

HALFF ASSOCIATES, INC.
Mechanical Engineering
Electrical Engineering
Plumbing Engineering
Fire Protection

COMBS CONSULTING GROUP
Information Technology

GARABEDIAN ASSOCIATES
Code Consulting
Life Safety

PROJECT MANUAL TITLE PAGE

OWNER:	The Board of Regents of the University of Texas System U.T. System Office of Facilities Planning and Construction 702 Colorado, Suite 4.100 Austin, Texas 78701
PROJECT:	University of Texas Rio Grande Valley School of Medicine – Team Based Learning Center Edinburg, Texas
DATE:	**November 8, 2018**
PROJECT NUMBER:	OFPC Project Number: 903-1159 A/E Project Number: A17021.00
OWNER'S REPRESENTATIVE:	Laura Lara, AIA, Senior Project Manager Office of Facilities Planning and Construction The University of Texas System 2102 Treasure Hills Boulevard, Suite 3.124 Harlingen, TX 78550 Phone 956-296-1512, Mobile 210.643.6616
PROJECT ARCHITECT:	Geof Edwards, AIA, Principal-in-Charge Munoz and Company, Inc. 1017 N. Main Avenue, Suite 300 San Antonio, TX 78212 Phone 210-349-1163, Fax 210-525-1038

PROJECT MANUAL CERTIFICATIONS

PROJECT: University of Texas Rio Grande Valley
School of Medicine – Team Based Learning Center
Edinburg, Texas
Project Number: 903-1159

PROJECT ARCHITECT/ENGINEERS/CONSULTANTS:

PROJECT ARCHITECT:
Geof Edwards, AIA
Munoz and Company, Inc.
1017 N. Main Avenue, Suite 300
San Antonio, Texas 78212
Phone 210-349-1163
Fax 210-525-1038

11-08-08

CIVIL ENGINEERS:
Perez Consulting Engineers
808 Dallas Avenue
McAllen, Texas 78501
Phone 956.631.4482

LANDSCAPE ARCHITECTS:
SSP Design
789 E. Washington Street
Brownsville, Texas 78520
Phone 956.547.9788
Fax 956.547.9977

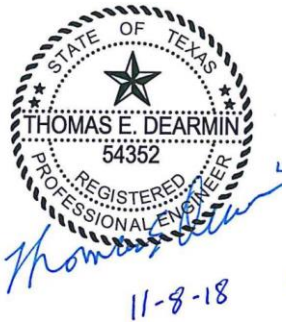
11-08-18

STRUCTURAL ENGINEERS:
Intelligent Engineering Services
200 S. 10th Street, Suite 1204
McAllen, Texas 78501
Phone956.682.4645
Fax

PROJECT MANUAL CERTIFICATIONS

PROJECT: University of Texas Rio Grande Valley
School of Medicine – Team Based Learning Center
Edinburg, Texas
Project Number: 903-1159

MECHANICAL / ELECTRICAL / PLUMBING/ FIRE PROTECTION ENGINEERS:
Halff Associates, Inc.
5000 West Military, Suite 100
McAllen, Texas 78503
Phone 956-445-5207



INFORMATION TECHNOLOGY & SECURITY CONSULTANTS:
Combs Consulting Group
8200 IH-10 West, Suite 103
San Antonio, Texas 78230
Phone 210-698-7887

CODE CONSULTING/ LIFE SAFETY:
Garabedian Associates
16218 Juan Tabo Way
Helotes, Texas 78023
Phone 210.592.1325

HARDWARE CONSULTANT:
RB Sontag AHC, CDC, FDAI.
Allegion PLC
9330 Corporate Drive, Suite 806
Selma, Texas 78154
(210) 842-7709 (Cell/Preferred)
(210) 541-4370 (Office)
(210) 455-9846 (Fax)

U.T. RIO GRANDE VALLEY
SCHOOL OF MEDICINE TEAM BASED LEARNING CENTER
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SECTION 21 00 00 – BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Fire Protection Requirements specifically applicable to Division 21 sections, in addition to Division 01 - General Requirements.

1.2 RELATED DOCUMENTS

A. Basic and supplemental requirements common to Fire Protection.

B. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.

C. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.3 GENERAL

A. The Contractor shall execute all work herein after specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the drawings

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation

C. The Fire Protection drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and 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 organized and laid out so that it will be concealed in furred chases, above suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Or where no ceilings exist. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted. All work shall be NFPA compliant and compliant with Insurance Underwriter requirements and guidelines.

D. When the Fire Protection drawings do not give exact details as to the elevation of pipe the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas, unless there is no ceiling.

1.4 DEFINITIONS

A. These definitions are included to clarify the direction and intention of these Specifications. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.

1. Concealed / Exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

2. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.

3. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

4. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

5. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

6. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

7. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

8. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

9. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.05 PERMITS, UTLILITY CONNECTIONS AND INSPECTIONS

A. General: Refer to Division 01 for construction phasing and time increments.

B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.6 CONTRACT DRAWINGS

A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the specifications, the drawings, and the schedules are as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.7 ALLOWANCES

A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.8 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.

C. Schedule of Alternates: See "Special Conditions" and Bid Form.

D. Any Alternate Proposals are summarized in Division 01 of the specifications. The Contractor is directed to refer to all sections of the specifications and drawings for this project to determine the exact extent and scope of the various Alternate Proposals as each pertains to the work of all trades.

1.9 SUBMITTALS

A. Refer to Division 1, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

B. Proposed Products List: Include Products specified in the following sections:

1. Section 21 05 29 – Fire Protection Supports and Sleeves

2. Section 21 05 53 – Fire Protection Piping and Equipment Identification

3. Section 21 13 13 – Fire Protection Systems

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

F. Submit Pipe Flushing Procedures with the fire protection submittals for review and comment by Engineer/Owner. Flushing Procedure shall comply with NFPA 13.

1.10 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers' data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the shop drawings.

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.11 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.12 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.13 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA)

1. NFPA No. 13, Sprinkler System, Installation
2. NFPA No. 14, Standpipes and Hose Systems
3. NFPA No. 20, Centrifugal Fire Pumps
4. NFPA No. 37, Stationary Combustion Engines & Gas Turbines
5. NFPA No. 45, Fire Protection for Laboratories Using Chemicals
6. NFPA No. 70, National Electrical Code
7. NFPA No. 72D, Proprietary Signaling Systems
8. NFPA No. 88A, Standard for Parking Structures
9. NFPA No. 99, Health Care Facilities
10. NFPA No. 101, Life Safety Code

C. American National Standards Institute (ANSI)

D. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards

E. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

F. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

G. City of Edinburg, Fire Department as may be applicable to construction on this site.

H. Texas Occupational Safety Act: All applicable safety standards.

I. Occupational Safety and Health Act (OSHA).

J. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

K. Refer to specification sections hereinafter bound for additional Codes and Standards.

L. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

M. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations

1.14 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.15 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of [Owner] [Architect/Engineer] before proceeding.

1.16 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, testing and piping of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer’s directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.17 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of Fire Protection equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.18 LARGE APPARATUS

A. Any large piece of apparatus that is to be installed in any space in the building, and that is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.19 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.20 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.21 ELECTRICAL WIRING OF EQUIPMENT

A. The Contractor shall note that the electrical design and drawings are based on the equipment scheduled and indicated on the drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 21.

C. Provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor.

1.22 SUPERVISION

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.23 SITE OBSERVATION

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.24 INSTALLATION METHODS

A. Where to Conceal: All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping."

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 5 working days or as agreed by the Project Manager.

3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid shall be complete and installed in accordance with contract requirements, including power to other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager's Construction Inspector(s), the Resident Construction Manager, and Office of Facilities Planning and Construction (OFPC). Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.25 RECORDS FOR OWNER

A. The Contractor shall maintain a set of "blueline" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these specifications, and to the Uniform General Conditions, for additional information. These drawings shall include as a minimum:

1. Addendum written drawing changes.

2. Addendum supplementary drawings.

3. Accurate, dimensioned locations of all underground utilities, services and systems.

4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.

5. Change Order written drawing changes.

6. Change Order supplementary drawings.

C. Electronic Media

1. The contractor shall submit three compact discs containing all the drawings in AUTOCAD 12 or 14 format.

D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.

2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.

3. Valve tag charts and diagrams specified herein.

4. Approved wiring diagrams and control diagrams representing "as installed" conditions.

5. Copies of approved shop drawings.

6. Any and all other data and/or drawings required as submittals during construction.

7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.26 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.27 ROOF PENETRATIONS AND FLASHING

A. Pipe, sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.28 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of piping. All exterior lines shall be installed with a minimum cover of 24," unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room to complete the pipe joint . Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6" below the trench depths specified. The over depth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for water lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

B. Backfilling

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

C. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of it. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.29 OPERATION PRIOR TO COMPLETION

A. When any piece of Fire Protection equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Project Manager’s written permission to do so. The warranty period shall, however, not commence until the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, properly adjust and complete all deficiency list items prior to being started, commissioned and before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.30 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workers, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of the fire protection system for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall them upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, and piping.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, coordination meetings shall be included in the contract amount.

1.31 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Check inspections shall include fire sprinkler piping, equipment,overall fire protection system controls, and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.32 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.33 CLEANING AND PAINTING

A. All equipment and piping, etc., furnished and installed in exposed areas under Division 21 of these specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 21 work.

B. All purchased equipment shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metalwork shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

D. Color of finish painting shall be painted in accordance with The University of Texas Standard Color Schedule for machinery spaces using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L" PAINT NUMBER
Fire Protection Equipment and Piping	Safety Red	R131R (Vibrant Red)

E. Jacketing on insulation shall not be painted.

F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

G. Scope of painting for Division 21--work in areas other than those defined as "exposed" is as follows:

1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers in underfloor spaces shall be cleaned and painted with two coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.

2. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.

3. All fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA.

4. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.2 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.

C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.

1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.3 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.

B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.

C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

D. Plates will not be required for piping where pipe sleeves extend ¾-inch or more above finished floor.

2.4 ROOF PENETRATIONS AND FLASHING

A. Pipe sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

D. Space Requirements:

1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations, as shown on the drawings and stated in the specifications.

C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.

D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

E. Flush piping as approved in Piping Flushing Procedure submittal.

F. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.

G. Precedence of Materials:

1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.

2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":

a. Building lines

b. Structural members

c. Structural support frames supporting ceiling equipment

d. Electric tracked vehicle system

e. Soil and drain piping

f. Vent piping

g. Supply, return and outside air ductwork

h. Exhaust ductwork

i. HVAC water and steam piping

j. Condensate piping

k. Fire protection piping

l. Domestic water (cold and hot, softened, treated)

m. Electrical conduit

3. Coordinate fire protection system with other trade systems as required to maintain system right-of-ways.

3.3 TESTING

A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean and properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

C. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.

D. Notify the Project Manager and the Architect/Engineer in writing at least five (5) calendar days or as agreed by the Project Manager prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.

E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results an other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

F. Maintain Log of Tests as hereinafter specified.

G. See specifications hereinafter for additional tests and requirements.

H. Refer to Commissioning Specification Sections for additional Start-up, prefunctional and operational checkout, and for functional performance test procedures.

3.4 TRAINING

A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled "Project Closeout Procedures."

B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION 21 00 00

SECTION 21 05 29 – FIRE PROTECTION SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 21 00 00 – Basic Fire Protection Requirements

B. Section 21 05 53 – Fire Protection Piping and Equipment Identification

1.2 SECTION INCLUDES

A. Pipe and equipment hanger and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.3 RELATED SECTIONS

A. Section 03300 – Cast-In-Place Concrete: Equipment bases

B. Section 07 84 00 – Firestopping: Joint seals for piping penetration of fire rated assemblies

C. Section 09 91 00 – Painting

D. Section 21 13 13 – Fire Protection Systems

E. Section 21 30 00 – Fire Pumps

1.4 REFERENCES

A. ASME B31.1 – Power Piping

B. ASME B31.9 – Building Services Piping

C. ASTM F708 – Design and Installation of Rigid Pipe Hangers

D. MSS SP58 – Pipe Hangers and Supports – Materials, Design and Manufacturer

E. MSS SP69 – Pipe Hangers and Supports – Selection and Application

F. MSS SP89 – Pipe Hangers and Supports – Fabrication and Installation Practices

G. NFPA 13 – Installation of Sprinkler Systems

H. NFPA 14 – Installation of Standpipe and Hose Systems

I. UL 203 – Pipe Hanger Equipment for Fire Protection Service

1.5 SUBMITTALS

A. Submit under provisions of Section 21 00 00.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.6 REGULATORY REQUIREMENTS

A. Supports for Sprinkler Piping: Shall be in conformance with NFPA 13.

B. Supports for Standpipes: Shall be in conformance with NFPA 14.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. Hangers and Supports:

1. Anvil International.
2. Kinder.
3. Cooper B-Line.
4. Power Strut.
5. Unistrut

B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, supports, joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided unless specifically indicated to be provided by others.

D. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

E. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

F. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

G. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

H. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

I. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Anvil Fig. CT-99c, adjustable, copper plated, tubing ring. Hangers supporting and contacting brass or copper lines 4" and larger shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Anvil Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

J. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

K. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Anvil Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two-hole rigid pipe clamps at 4 ft. o.c. or steel framing channels and Anvil Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. Where brass or copper lines are supported on trapeze hangers or steel framing channels, the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The Contractor shall use a drilled anchor as specified above, and use a Anvil No. 595 Socket Clamp with Anvil No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

L. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

M. All electrical conduits shall be run parallel or perpendicular to adjacent building lines. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4") from the building structure. Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips." All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8' centers. Where feasible, conduits may be fastened to the concrete by one-hole straps thoroughly anchored to the concrete in an approved manner. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above-ceiling equipment, and to support it from touching the ceiling system. Conduit shall be located so as not to inhibit removal of ceiling tiles.

N. Vertical conduits shall be supported as often as necessary for rigidity by clamps resting on adjacent beams or floor slabs, using a minimum of one support per floor.

O. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

P. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping that may vibrate and create an audible noise shall also be isolated.

Q. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:

a. Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.

e. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

g. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

NOTE: UNDER NO CIRCUMSTANCES WILL THE USE OF PLASTIC ANCHORS OR PLASTIC EXPANSION SHIELDS BE PERMITTED FOR ANY PURPOSE WHATSOEVER.

R. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Cooper BLine, Uni-Strut, Power Strut, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

S. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. Universal concrete inserts shall be cadmium plated.

T. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

U. All hangers and supports for fire standpipe systems and fire sprinkler systems shall be Factory Mutual and Underwriters Laboratories, Inc. listed and labeled. Construction of hangers shall be as described above for common piping, except for the above-mentioned requirements.

2.2 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: 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. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.3 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized steel.

B. Metal Counterflashing: 22 gauge galvanized steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

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2.4 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS"):

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

2.5 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.6 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.

2. Sleeves through interior walls to be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Vermin proofing: The open space around all piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

G. Air Plenums: The space around piping, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

H. Fireproofing: Seal all pipe, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000° F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be a silicone RTV foam or an approved equal. For dry locations, a premixed putty equal to Nelson Flameseal Firestop putty may be used

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide 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 over 4 inches.

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 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

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 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple 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. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.

L. Hanger Rods: (NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.)

3.4 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Provide acoustical lead flashing around pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

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.

3.5 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors (except in stairwells) two inches above finished floor level. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where piping penetrates floor, ceiling, or wall, close space between pipe and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.6 PIPE SUPPORT SCHEDULE

STEEL PIPE SIZE Inches	MAX. HANGER SPACING Feet	HANGER ROD DIAMETER Inches

1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8

END OF SECTION 21 05 29

SECTION 21 05 53 – FIRE PROTECTION PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 The following sections are to be included as if written herein:

A. Section 21 00 00 – Basic Fire Protection Requirements.

B. Section 21 05 29 – Fire Protection Supports and Sleeves.

1.2 SECTION INCLUDES

A. Nameplates

B. Tags

C. Stencils

D. Pipe Markers

1.3 RELATED SECTIONS

A. Section 09 91 00 – Painting: Identification painting.

1.4 REFERENCES

A. ASME A13.1 – Scheme for the Identification of Piping Systems.

1.5 SUBMITTALS

A. Submit under provisions of Section 21 00 00.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified of implied in the specification.

F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 21 00 00.

B. Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

A. Equipment Tags, Valve Tags, and Markers:

1. Marking Systems, Inc.
2. Seton Name Plate Company.
3. W.H. Brady Company.
4. Graphic Products, Inc.

2.3 EQUIPMENT

A. Description: 3” x 4” vinyl label, 3.0 Mil self-adhesive vinyl similar to DuraLabel Pro. Label color shall be black text on a white background. The label shall contain the following information per the template, described in Attachment “B”:

1. Asset Short Description As listed in Equipment Matrix.
2. Asset Number: As listed in Equipment Matrix.
3. Asset Location: As listed in Equipment Matrix.
4. Asset Bar Code Number.

B. All scheduled equipment shall be identified with an Equipment Tag.

2.4 VALVE TAGS

A. Valve tags shall conform to ANSI A13.1-1981 "Scheme for the Identification of Piping Systems", refer to Attachment “A” for abbreviation, and label color designations.

B. Valve tags shall be black ABS plastic tags: Injected molded ABS plastic, 3.375” X 4.75” with self-adhesive vinyl label, similar to DuraLabel Pro, affixed to valve tag. Each tag shall be attached to its valve with one tie strap.

C. Vinyl Label: 3.0 Mil self-adhesive vinyl similar to DuraLabel Pro. Label color shall be as per the standard designated colors listed in the attachment to this specification. The label shall contain the following information as per template, refer to Attachment “B”:

1. Asset Short Description: As listed in Equipment Matrix.
2. Asset Number: As listed in Equipment Matrix.
3. Asset Location: As listed in Equipment Matrix. .
4. Asset Bar Code Number.

D. Each valve shall be named as per attached valve tag naming convention, refer to Attachment “C”.

E. In addition to valve tags, valves at PRV stations, and other valves as specified shall be tagged with standardized color coded plastic tags. Each tag shall be attached to its valve with one tie strap. These tags shall be 2-½ inches wide by 1-½ inches high with these color codings:

1. Red = normally closed.

2. Green = normally open.

3. Blue = open in winter, closed in summer.

4. Yellow = closed in winter, open in summer.

F. Valve Tag Fasteners: Single ABS plastic tie strap.

2.5 PIPE MARKERS

A. Pipe Markers shall conform to ANSI A13.1-2007 "Scheme for the Identification of Piping Systems" as indicated below.

Pipe Contents	Label Abbreviation	Label Colors (Background/Text)
Fire Suppression Water	FIRE	Red/White
Dry Pipe Sprinklers	DRY FIRE	Red/White
Pre-action Sprinklers	PREACTION	Red/White
Wet Sprinklers	WET FIRE	Red/White

B. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Heat sealed or heat shrink, spring fasteners, clips or snap-on are acceptable.

E. Underground Plastic Pipe markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

F. Pipe markers and arrow markers also shall be provided for all piping systems.

G. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, up through 6 inch. For piping systems larger than 6 inches, use Seton or Brady strap-on markers or similar by Marking Services, Inc.

2.6 CEILING GRID TAG FOR EQUIPMENT LOCATED ABOVE LAY-IN CEILING

A. Description: 3/4” x variable length” vinyl label, 3.0 Mil self-adhesive vinyl similar to Dura Label Pro. Label color shall be black text on a white background. The label shall contain the following information per the template, described in Attachment “C”:

1. Asset Short Description:As listed in Equipment Matrix.

2. Asset Bar Code Number.

B. All scheduled equipment above finish lay-in ceiling shall be identified with an Equipment Tag.

C. All ceiling grid tags shall be installed prior to the ceiling cover inspection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Install plastic tape, and pipe markers completely around pipe in accordance with manufacturer's instructions.

D. Locate markers on the two (2) lower quarters of the pipe where view is unobstructed.

3.2 VALVE TAGS

A. Contractor(s) shall provide and install valve tags on all valves installed within this Project, except check valves; Existing valve tags shall not be attached to new valves. When removing and/or replacing existing tagged valves, give the Owner all existing tags that are attached to the valves that are removed. New tags with new asset numbers shall be provided for new valves.

3.3 APPLICATION OF MARKERS AND STENCILS

A. Piping runs throughout the Project including those above lift-out ceilings, under floor and those exposed to view when access doors or access panels are opened shall be identified by means of pipe markers and/or stencils. Concealed areas, for purposes of this identification section, are those areas that cannot be seen except by demolition of the building elements. In addition to pipe markers and/or stencils, arrow markers shall be used to indicate direction of flow.

B. As a minimum, locate pipe markers and/or stencils as follows:

1. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one (1) header, it is necessary to mark only the header.

2. Every 20 feet in exposed and concealed areas on all piping systems. Provide at least one (1) pipe marker in each room on all piping systems.

3. At each branch or riser take off on piping systems, excluding short takeoffs for fixtures.

4. Provide a pipe marker or stencil and an arrow marker at every point of pipe entry or exit where the pipe penetrates a wall, floor, service column or enclosure.

    a) At access doors, manholes and similar access points that permit view of concealed piping.

    b) Near major equipment items and other points of origination and termination.

C. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

D. Provide a double-ended arrow marker when flow can be in either or both directions.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments and relays. Key to control schematic.

I. Provide ceiling grid tags to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of grid closest to equipment.

J. Identify right and left nipple and coupling union assemblies with the statement “Right/Left Nipple/Coupling”.

END OF SECTION 21 05 53

SECTION 21 08 00 - COMMISSIONING OF FIRE PROTECTION SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for Fire Protection systems, assemblies, controls, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

1.2 RELATED SECTIONS

A. SECTION 01 91 00 - COMMISSIONING GENERAL REQUIREMENTS

B. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS

C. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

D. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

E. SECTION 28 08 00 – COMMISSIONING OF FIRE ALARM SYSTEMS

1.3 DEFINITIONS

A. Refer to section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.4 SUBMITTALS

A. Certificate Of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for details of contractor’s responsibilities related to commissioning.

B. Perform commissioning tests at the direction of the CxA.

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

F. Functional testing of systems will be carried out solely by contractor's personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.6 CxA'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing.

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 21 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.

C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that Fire Protection systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that testing, adjusting, and balancing procedures for Fire Protection systems have been completed and submitted, discrepancies corrected, and corrective work approved.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.4 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Plumbing systems.

B. Provide measuring instruments to record test data as directed by the CxA.

3.5 PIPING SYSTEMS

A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.6 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.7 RE-TESTING

A. Reference Project Specification Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Plumbing systems.

3.8 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 COMMISSIONING GENERAL REQUIREMENTS for list of Plumbing systems to be commissioned.

END OF SECTION

SECTION 21 13 13 – FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 21 00 00 – Basic Fire Protection Requirements

B. Section 21 05 29 – Fire Protection Supports and Sleeves

C. Section 21 05 53 – Fire Protection Piping and Equipment Identification

1.2 SECTION INCLUDES

A. Pipe, fittings, valves, and connections for sprinkler, standpipe and fire hose, and combination sprinkler and standpipe systems.

1.3 RELATED SECTIONS

A. Section 31 23 16.13 – Trenching

B. Section 09 91 00 - Painting

C. Section 22 20 00 – Plumbing, Piping, Valves and Fittings

1.4 REFERENCES

A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.

C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

E. ANSI/ASME B16.9 - Factory-made Wrought Steel Buttwelding Fittings.

F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.

G. ANSI/ASME B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.

H. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

I. ANSI/ASME B16.25 - Buttwelding Ends.

J. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

K. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

L. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.

M. ANSI/ASTM A47 - Malleable Iron Castings.

N. ANSI/ASTM B32 - Solder Metal.

O. ANSI/AWS A5.8 - Brazing Filler Metal.

P. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings.

Q. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.

R. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

S. ASTM A120 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated (Galvanized) Welded and Seamless, for Ordinary Uses.

T. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

U. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

V. ASTM B75 - Seamless Copper Tube.

W. ASTM B88 - Seamless Copper Water Tube.

X. ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

Y. ASTM F442 - Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).

Z. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

AA. NFPA 13 - Installation of Sprinkler Systems.

BB. NFPA 14 - Standpipe and Hose Systems.

CC. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances

DD. UL - Fire Protection Equipment Directory.

EE. City of Edinburg , Texas, Fire Department Standards.

FF. State of Texas, State Fire Marshal Rules.

GG. All hose threads, coupling types, etc., utilized in the fire protection systems shall conform to the standards and requirements of the City of Edinburg , Texas Fire Department.

1.5 SUBMITTALS

A. Submit under provisions of Section 21 00 00.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

C. Product Data: Provide data on sprinkler heads, valves, and specialties, including manufacturer’s catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds

requirements specified, and suggested by listed codes.

E. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 21 00 00.

B. Maintenance Instructions: Include installation instructions, spare parts lists, procedures, and treatment programs.

1.7 QUALITY ASSURANCE

A. Sprinkler Systems: Perform work to NFPA 13.

B. Standpipe and Hose Systems: Perform to NFPA 14.

C. Welding Materials and Procedures: Perform to ASME Code.

D. Equipment and Components: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

E. Maintain one copy of each document on site.

F. Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas. All design submittal documents and shop drawings shall bear the responsible engineers signed and dated seal.

G. All parts of fire protection piping systems shall conform to all provisions of Underwriters' Laboratories requirements. All equipment shall bear the Underwriters' Laboratories label of approval.

H. Determine volume and pressure of incoming water supply from residual pressure water flow test.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 21 00 00.

B. Deliver and store valves in shipping containers, with labeling in place.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 - PRODUCTS

2.1 UNIONS:

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines. Unions 2 inch and smaller shall be Class 300 AAR threaded malleable iron unions with iron to brass seats, and 2 ½ inch and larger shall be ground flange unions. Companion flanges on

lines at various items for equipment machines and pieces of apparatus shall serve as unions to permit removal of the particular items.

2.2 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

2.3 FLANGE GASKETS

A. Gaskets shall be placed between the flanges of all flanged joints.

B. Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16” thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

C. Spares - Contractor shall provide ten spares for every flange size and rating.

2.4 WALL, FLOOR AND CEILING PLATES:

A. See Section 21 00 00.

2.5 SLEEVES, INSERTS, AND FASTENINGS:

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, etc., shall be sleeved. Refer to Specification Section 21 05 29.

2.6 MATERIALS:

A. PIPING:

1. All pipe used for fire protection standpipe systems and fire sprinkler systems shall be

Schedule 40 black steel pipe conforming to ASTM A-795 or ASTM A-53. All piping 2 1/2" and larger shall be welded, unless otherwise indicated herein.

2. Use of piping, when approved by UT System, shall be “roll” grooved type; cut grooved pipe is not permitted.

3. No pipe smaller than 4" nominal pipe size shall be used for standpipe systems except for individual runouts to one hose cabinet. The 1-1/2" or 2-1/2" runout to cabinet shall have a maximum center line height of 60".

4. Scheduled 10 pipe is not permitted.

B. FITTINGS:

1. All welding type steel fittings employed in fabricating fire protection standpipe system and fire sprinkler systems shall conform to A.S.T.M. Specification A-234 and ANSI Standard B16.9-1964. All threaded fittings shall be Class 150 malleable iron fittings conforming to ASME B16.3. Grooved type fittings will not be accepted for use in standpipe systems unless specifically indicated. Pipe size changes shall be performed through the use of reducing tees or reducers designed for that purpose. The use of bushings is explicitly prohibited.

2. Unless otherwise shown or required, all fittings shall be welding type steel fittings. Refer to specification Section 22 20 00.

3. Threaded fittings shall be used when shown and shall be used from the point of connection of the pipe to the riser to each fire hose cabinet. Threaded fittings shall be Crane or Grinnell Company's Class 150 malleable iron fittings.

4. Grooved end couplings 2 ½” and larger shall be Victaulic Style 07 “Zero-Flex” Rigid Coupling, with EPDM gasket (minimum 700 psi working pressure) for use with roll grooved piping. Products by Gustin-Bacon, Gruvlok are acceptable, or Engineer-approved equal. Reducing type couplings, outlet couplings, “T” outlet fittings, cut-in style fittings, snap joint couplings, and flange adapter type fittings are not acceptable. Provide grooved fittings similar to standard weld fittings.

5. Extra heavy "Thread-o-lets" shall be used at each point of departure from the riser to the fire hose or valve cabinet. A "Thread-o-let" shall be installed below the level of the valve in the cabinet and a minimum of two (2) threaded ells shall be used to provide a swing joint connection from the riser to the valve in the cabinet.

2.7 VALVES:

A. General – All shutoff valves shall be UL listed and FM approved for fire protection service.

B. Shutoff valves for sizes 2 inch and smaller:

1. Two piece bronze ball valve, bubble-tight shutoff, full port, blow-out proof stem, chrome plated brass ball and silicon bronze stem, threaded end connections, conforming to MSS SP-110.

2. One piece, butterfly valve, full port, threaded ends, bronze housing and body, stainless steel disc. EPDM disc seal and slow closing.

3. All valves shall be furnished with two factory mounted internal supervisory switches.

C. Shut off valves for sizes over 2 inch:

1. Butterfly valves lug type with EPDM molded in seat liner, ductile iron disc, stainless steel stem, manual gear operator, conforms to MSS SP-67 and MSS SP-25, with integral supervisory switch. Where a grooved piping system is allowed grooved end type butterfly valves may be used, consisting of ductile iron body and disc EPDM seats, stainless steel stem. Valves shall be equipped with internal supervisory switch.

2. Gate valves – OS&Y (Outside Yoke and Stem) resilient wedge, epoxy coated interior and exterior, ASTM A 536 ductile iron valve body, bonnet and resilient wedge, ASTM B150 stem and flanged ends.

D. Check valves for sizes 2 inch and smaller:

1. Horizontal swing, bronze body, conforming to MSS Sp-80, threaded ends and rubber disc.

E. Check valves for sizes over 2 inch:

1. Iron body swing-check, bronze disc, seat ring and hinge pin, UL listed and FM approved, flanged ends, renewable seats and disc, tapped ¾ inch for ball drip assembly.

F. Standard of Quality for Fire Protection Valves:

Size	Type	Class	Manufacturer
2” and Smaller	Ball	300	Nibco No. KT-505-W-8, Stockham No. T-255-FB-P-UL
2” and Smaller	Butterfly	175	Milwaukee No. BB-SC02
2 ½” and Larger	Butterfly (lug)	250	Nibco No. LD3510-8
2 ½” and Larger	Butterfly (grooved)	300	Nibco No. GD-4765-8N
2” and Smaller	Check	200	Nibco No. KT-403-W
2 ½” and Larger	Check	175	Nibco No. F-908-W
2 ½” and Larger	Check (grooved)	250	Nibco No. G-917 W

2.8 BACKFLOW PREVENTERS:

A. Provide double check valve assembly on fire water service entry inside building, unless local municipality requires a reduced pressure type backflow preventer. Double check valve assembly shall be UL listed, FM approved and ASSE 1015 listed, with flanged OS & Y resilient seated gate valves with type 304 schedule 40 stainless steel housing and sleeve with replaceable check disc rubber, manufactured by Watts No. 757OSY or approved equal by Wilkins or Apollo.

2.9 SPRINKLER SYSTEM

A. SYSTEM DESCRIPTION

1. System to provide coverage for entire building.

2. Provide system to NFPA 13 light hazard occupancy requirements unless otherwise noted. Refer to “FP” drawings for locations of design densities of specific rooms and areas.

3. Interface system with building fire and smoke alarm system.

B. SUBMITTALS

1. Submit under provisions of Section 21 00 00.

2. Preliminary Shop Drawings: Prior to detailed submission, submit preliminary layout of finished ceiling areas indicating only head locations coordinated with ceiling installation.

3. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.

4. Submit shop drawings, product data, and hydraulic calculations to Factory Mutual for review. Submit copies of all information, and review comments to Architect/Engineer and Owner.

5. Samples: Submit two of each style of sprinkler head specified.

C. PROJECT RECORD DOCUMENTS

1. Submit under provisions of Section 21 00 00.

2. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.

D. OPERATION AND MAINTENANCE DATA

1. Submit under provisions of Section 21 00 00.

2. Maintenance Data: Include components of system, servicing requirements, Record Drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

E. QUALITY ASSURANCE

1. Perform Work in accordance with NFPA 13.

2. Equipment and Components: Bear FM label or marking.

3. Maintain one copy of all documents on site.

F. EXTRA MATERIALS

1. Furnish under provisions of Section 21 00 00.

2. Provide extra sprinkler heads as suggested under provisions of NFPA 13.

3. Provide suitable wrenches for each head type.

4. Provide metal storage cabinet in location designated.

G. PRODUCTS

1. General: The Contractor shall provide all components required for the complete installation of automatic sprinkler systems as hereinafter specified and indicated on the Drawings.

2. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association and Fire Protection and Engineering Bureau of Texas, or by an authorized agent of such firm. Evidence to support the above requirements may be required and any proposed installer who cannot show suitable experience will be rejected.

3. System Layout: The fire sprinkler areas, piping, head locations, etc. as indicated is only for Contractor's reference as to areas to be protected and possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire sprinkler system as described herein and on the project drawings. The piping of the system shall be sized used the "hydraulic" method, as included in NFPA Standard No. 13. Piping sized using the "schedule" method is unacceptable, except where expanding an existing "scheduled" system.

4. Shop Drawings: Shop Drawings shall be submitted prior to fabrication. The Shop Drawings shall include detail plans of sprinkler systems including piping sizes, sections and plot plan indicating the locations of underground supply connections, control valves, fire department connections, and other equipment to be used. The Shop Drawings shall become an integral part of these Specifications.

5. Materials and Equipment:

    a. General: All materials and equipment used in the installation of the sprinkler system shall be listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials, or the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard, and shall be the latest design of the manufacturer. All piping, control valves, drain valves, fittings, etc. shall be as specified under this Section, Fire Protection System, & in Section 22 20 00 utilizing welded, flanged, and threaded fittings only. Where valves are not specified by Figure No. they shall be of specified manufacture, U.L. listed for service, and of same quality level as Figure Nos. specified. All pipe 2 1/2" and larger shall be welded, except as may be allowed herein. All pipe 2" and smaller shall be threaded using Class 150 pound malleable iron, A135 Schedule 40 black steel pipe and fittings. Note that if galvanized pipe or fittings are installed in other than dry systems, the contractor shall be responsible to remove the galvanized pipe or fittings and replace them with specified materials as soon as possible prior to further installation of the system. (EXCEPTION: Dry pipe systems shall be hot dipped galvanized pipe and fittings of same schedule as dry systems, per Factory Mutual recommendations.)

6. Sprinkler Heads:

    a. Unless otherwise specified or indicated on the Drawings, sprinkler heads shall be quick response type spray heads of the upright or pendant ordinary degree temperature rating type except that sprinkler heads to be installed in the vicinity of heating equipment and lights shall be of the temperature rating required for such locations by National Fire Protection Association Standard No. 13. Chrome plated bronze heads shall be installed in all locations.

    b. Heads shall be located in a symmetrical pattern related to ceiling features such as grid, beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrically with the ceiling grid, centered in two directions.

c. The Contractor shall provide spare heads equal to one percent (1%) of the total number of heads installed under the Contract, but not less than ten (10). The heads shall be packed in a suitable wall mounted sprinkler cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating heads installed. In addition to the spare heads, the Contractor shall provide not less than one special sprinkler head wrench for each type of head. The cabinet shall be located where directed by the Construction Inspector.

7. Piping: Installation of piping, fittings and valves shall be as specified in Chapter 3, System Components, NFPA Standard No. 13, except where noted otherwise. Piping shall be concealed in all areas with finished ceilings. Piping shall be sterilized as specified in Section 21 20 00. The O.S.& Y. valves shall be provided as specified herein.

8. Note that the use of piping bushings for any purpose is explicitly prohibited.

9. Water Alarm: A water motor alarm shall be connected to each alarm valve and shall discharge to a brass alarm gong located on the exterior of the building as directed by the Architect. Alarm gong finish to be selected by the Architect. The alarm valves shall be Underwriters' Laboratories approved, wet type, connected to water supply and indicated on the Shop Drawings. Each alarm valve shall be provided with a circuit closer. Valves shall conform to the equipment of NFPA Standard No. 13, complete with retarding chamber and pressure switch.

10. Water Flow Alarm Switch: Provide, where indicated on the Drawings, McDonnell UL approved line size flow switches. Flow switch shall be provided with delay, adjustable up to 90 seconds (60 to 90 seconds in Austin). See Division 26 for electrical signal connection by others to these flow switches.

H. Add locations and hazards as required by project conditions.

Location	System Type/Hazard
Offices, Lobbies	Light Hazard
Mechanical Rooms	Ordinary Hazard, Group 2
Computer Rooms	Light Hazard, Pre-action

2.10 STANDPIPE SYSTEMS:

A. General: The Contractor shall provide all components required for the complete installation of standpipe systems as hereinafter specified and indicated on the Drawings.

B. Qualifications of the Installer: The system shall be installed by a firm regularly engaged in the design and installation of automatic sprinkler systems in accordance with requirements of the National Fire Protection Association and Fire Protection and Engineering Bureau of Texas, or by an authorized agent of such firm. Evidence to support the above requirements may be required and any proposed installer who cannot show suitable experience will be rejected.

C. System Layout: The fire zones, piping, etc. as indicated is only for Contractor's reference as to areas to be protected and for possible piping routes. If header or manifold sizes are given in the drawings, then the sizes given shall be the minimum sizes installed. Actual number, spacing and locations, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings. All layouts, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions shall be made without increase in cost to the Owner or the Architect/Engineer. Modifications to head spacing, pipe

routes, etc. shall be closely coordinated with the work of all other trades. The Fire Sprinkler Subcontractor shall be responsible for the design and installation of the fire system as described herein and on the project drawings.

D. Shop Drawings: Shop Drawings shall be submitted prior to fabrication. The Shop Drawings shall include detail plans of systems including piping sizes, sections and plot plan indicating the locations of underground supply connections, control valves, fire department connections, and other equipment to be used. The Shop Drawings shall become an integral part of these Specifications. Submit to Factory Mutual for review and comment.

E. Materials and Equipment:

1. General: All materials and equipment used in the installation of the sprinkler system shall be listed as approved by the Underwriters' Laboratories, Inc., List of Inspected Fire Protection Equipment and Materials, or the Factory Mutual Testing Laboratories List of Approved Equipment, Fire Protection Devices and Devices Involving Fire Hazard, and shall be the latest design of the manufacturer. All piping, control valves, drain valves, fittings, etc. shall be as specified under this Section, utilizing welded, flanged, and threaded fittings only. Where valves are not specified by Figure No. they shall be of specified manufacture, U.L. listed for service, and of same quality level as Figure Nos. specified. All pipe 2 1/2" and larger shall be welded, except as may be allowed herein. All pipe 2" and smaller shall be threaded using Class 150 malleable iron, A120 Schedule 40 black steel pipe and fittings. Note that if galvanized pipe or fittings are installed, the contractor shall be responsible to remove the galvanized pipe or fittings and replace them with specified materials as soon as possible prior to further installation of the system.

2.11 FIRE DEPARTMENT SIAMESE CONNECTIONS:

A. At the points designated on the accompanying Drawings, install Siamese fittings required for fire protection purposes. From a point on the incoming water supply line, the Contractor shall extend water line for fire protection purposes to Siamese connections.

B. Provide [2 way] [3way] [4 way] [6 way] free standing type Siamese shall be equal to Potter-Romer No. ____ cast brass body with 2 ½" outlets and escutcheon. They shall have proper caps with pin type lugs attached to the body of connection with substantial chains. "STANDPIPE" or "AUTOMATIC SPRINKLER" is to be cast on head of connection. All external surfaces shall be chromium plated polished surfaces or as directed by Architect.

2.12 ROOF MANIFOLDS:

A. Roof manifolds shall be equal to Potter Roemer cast brass Underwriters' Laboratory listed horizontal roof manifold. Complete with listed brass manufactured by Potter Roemer No. ____ valve and 2-1/2" brass caps and chains, 2 way outlets shall be 7-1/2 threads per inch iron pipe size.

B. Systems shall be flushed through a temporary hose until the system is clean. Any leaks found shall be remedied in each instance in a manner approved in advance by the Owner's duly authorized representative. The systems shall be alternately tested and repaired where necessary until they have demonstrated their capability to withstand the test pressure for a period of 24 hours without any appreciable drop in the test pressure initially applied.

PART 3 - EXECUTION

3.1 PREPARATION - ALL SYSTEMS:

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Flush entire system of foreign matter prior to installation of sprinkler heads.

3.2 SYSTEM TESTS

A. Hydrostatically test entire standpipe system in accordance with NFPA 14 and sprinkler system in accordance with NFPA 13, with a pressure of 200 psi maintaining that pressure with loss for 24 hours. Where portions of the system exceeds 150 psi working per the system shall be tested at a pressure of 50 psi in excess of the system working pressure for a 24 hour period.

B. Test shall be witnessed by campus Fire Marshal.

3.3 INSTALLATION

A. SPRINKLERS

1. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains. Note that the piping sizes indicated in the plans are the minimum acceptable. The Qualified Contractor shall provide proper sizes, materials and installation as required in the appropriate NFPA Standard.

2. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. See Section 21 00 00 and 21 05 29.

3. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

4. Provide drain valves at main shut-off valves, low points of piping and apparatus. Provide Fire Department test station, piped to drain.

5. Locate outside alarm gong on building wall as indicated.

6. Place pipe runs to minimize obstructions with other work.

7. Place piping in concealed spaces above finished ceilings.

8. Center heads in two directions in ceiling tile and provide piping offsets as required.

9. Apply paper cover to ensure concealed sprinkler head and cover plates do not receive field paint finish.

10. Install and connect fire pumps in accordance with Section 21 30 00 and NFPA 13.

11. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle.

B. STANDPIPES

1. Fire standpipe risers shall be located at the stairs as shown on the drawings. System shall

be [empty (dry without air pressurization) and] shall be complete with fire valves for Fire Department hose connections.

2. Install in accordance with manufacturer's instructions.

3. Install in accordance with NFPA 14 for standpipe and hose systems.

4. Locate and secure hose cabinet plumb and level. Establish top of cabinet surface 66 inches above finished floor.

5. All polyester hoses must be new and unused at the time of acceptance of the project.

6. Locate angle valve in cabinet at 60 inches above floor.

7. Locate dry chemical fire extinguisher in cabinet.

8. Connect standpipe system to water source ahead of domestic water connection.

9. Where static pressure exceeds 100 psi at any hose station, provide pressure reducing valve to prevent pressure on hose exceeding 90 psi.

10. Provide [two-way] [three-way] fire department outlet connection on roof.

END OF SECTION 21 13 13

SECTION 22 00 00 – BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Plumbing Requirements specifically applicable to Division 22 sections, in addition to Division 01 - General Requirements.

1.2 RELATED DOCUMENTS

A. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.

B. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.3 GENERAL

A. The Contractor shall execute all work hereinafter specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the drawings.

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.

C. The plumbing, mechanical, electrical, and associated drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and 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 organized and 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. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

D. When the mechanical, plumbing, and electrical drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, and located as high as possible against the structure. The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

1.4 DEFINITIONS

A. Concealed/exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

B. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.

C. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

D. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

E. And/Or: Where "and/or" is used in these specifications or on the drawings, it shall mean "that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.

F. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

G. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

H. Furnish

1. The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations."

2. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

I. Install: The term "install" is used to describe operations at project site including "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operation."

J. Provide: The term "provide" means "to furnish and install, complete and ready for intended use."

1.5 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

A. General: Refer to Division 01 for construction phasing and time increments.

B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.6 CONTRACT DOCUMENTS

A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the specifications, the drawings, and the schedules are as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.7 ALLOWANCES

A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.8 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.

C. Schedule of Alternates: See "Special Conditions" and Bid Form.

D. Any Alternate Proposals are summarized in Division 01 of the specifications. The Contractor is directed to refer to all sections of the specifications and drawings for this project to determine the exact extent and scope of the various Alternate Proposals as each pertains to the work of all trades.

1.9 SUBMITTALS

A. Refer to Division 1, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

B. Proposed Products List: Include Products specified in the following sections:

1. Section 22 05 13 – Plumbing Motors
2. Section 22 05 29 – Plumbing Supports and Sleeves
3. Section 22 05 48 – Plumbing Vibration Isolation
4. Section 22 05 53 – Plumbing Identification
5. Section 22 07 19 – Plumbing Insulation
6. Section 22 11 23 - Plumbing Equipment
7. Section 22 13 16 - Plumbing Piping
8. Section 22 13 16.A - Plumbing Specialties
9. Section 22 20 00 – Plumbing, Piping, Valves and Fittings
10. Section 22 40 00 - Plumbing Fixtures

C.

D. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.

E. Mark dimensions and values in units to match those specified.

F. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

G. All required fabrication drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0." Fabrication plans~~,~~ and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0." Submit three ~~blueline~~ prints of each fabrication drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one print with comments.

1.10 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers' data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the ~~designer~~ Architect/Engineer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the shop drawings. Such lists shall include but will not be limited to the following items:

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.11 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.12 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.13 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA)

1. NFPA No. 51, Welding & Cutting, Oxygen-Fuel Gas Systems

2. NFPA No. 70, National Electrical Code

3. NFPA No. 101, Life Safety Code

4. NFPA No. 241, Standard for Safeguarding Construction, Alteration and Demolition Operations

5. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials

6. NFPA No. 258, Standard Research Test Method for Determining Smoke Generation of Solid Materials

C. American National Standards Institute (ANSI)

D. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

E. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards.

F. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

G. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

H. City of Edinburg Fire Department as may be applicable to construction on this site.

I. International Plumbing Code, (Includes the International Mechanical and International Building Codes)

J. Texas Occupational Safety Act: All applicable safety standards

K. Occupational Safety and Health Act (OSHA)

L. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

M. Refer to specification sections hereinafter bound for additional Codes and Standards.

N. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

O. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.14 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.15 WALL, FLOOR AND CEILING PLATES

A. See Section 22 05 29 – Plumbing Supports and Sleeves

1.16 SLEEVES, INSERTS, AND FASTENINGS

A. See Section 22 05 29 – Plumbing Supports and Sleeves

1.17 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of [Owner] [Architect/Engineer] before proceeding.

1.18 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer's directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.19 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of plumbing equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.20 LARGE APPARATUS

A. Any large piece of apparatus that is to be installed in any space in the building, and that is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.21 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.22 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.23 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. The Contractor shall note that the electrical design and drawings are based on the equipment scheduled and indicated on the drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 22, shall be provided under the scope of Division 26.

C. The Plumbing Trade shall provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor. They shall be followed in detail.

1.24 SUPERVISION

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.25 SITE OBSERVATION

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.26 PRECEDENCE OF MATERIALS

A. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.

B. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the contractor in the determination of which trade shall be given the "Right-of-Way." Refer to Part 3 of these specifications.

1.27 CONNECTIONS FOR OTHERS

A. The Plumbing Contractor shall rough in for and make all gas, water, sewer, etc. connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing in drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.

D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome plated lines provided by others shall be chrome plated to match.

E. Provide all transition pieces, etc, required for a complete installation of vent hoods, fume hoods, etc. provided by others.

1.28 INSTALLATION METHODS

A. Where to Conceal: All pipes, etc., shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed, All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping and ducts shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. AII pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping, ducts and conduits run in furred ceilings, etc, shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces shall be neatly grouped and racked indicating good workmanship. AII conduit and pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping."

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Construction Manager shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Construction Manager shall give as much advance notice as possible no less than 10 working days.

3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, shall be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: Construction Manager and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager's Construction Inspector(s), the Resident Construction Manager, and Office of Facilities Planning and Construction (OFPC). Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems. the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.29 RECORDS FOR OWNER

A. The Contractor shall maintain a set of "blueline" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these specifications, and to the Uniform General Conditions, for additional information. These drawings shall include as a minimum:

1. Addendum written drawing changes.

2. Addendum supplementary drawings.

3. Accurate, dimensioned locations of all underground utilities, services and systems.

4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.

5. Change Order written drawing changes.

6. Change Order supplementary drawings.

C. Electronic Media

1. The contractor shall submit three sets of discs containing all the drawings in AUTOCAD 12 or 14 format.

D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.

2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.

3. Valve tag charts and diagrams specified herein.

4. Approved wiring diagrams and control diagrams representing "as installed" conditions.

5. Copies of approved shop drawings.

6. Any and all other data and/or drawings required as submittals during construction.

7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.30 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes, etc., shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All plumbing work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.31 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The mechanical subcontractors shall perform all excavations of every description, for their installations and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of piping, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24," unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level of the pipe, and may be made as wide as necessary for sheeting and bracing and proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the International Plumbing Code for the service intended and the size used. Bell holes for hub and spigot pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping, etc., shall clear the ground surface a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

B. Backfilling

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

C. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of it. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.32 ACCESS DOORS

A. General: This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of mechanical equipment or devices.

B. Doors: Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacture, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surface of the adjacent finishes. Access doors mounted on tile surfaces shall be of similar construction as noted above, except they shall be of stainless steel materials. Access doors shall be a minimum of 12" x 12" in size.

1.33 OPERATION PRIOR TO COMPLETION

A. When any piece of plumbing equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Project Manager or Construction Inspector's written permission to do so. The warranty period shall, however, not commence until the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.34 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workers, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall them upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.

1.35 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workers skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities that must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

1.36 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Before the work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. The qualifications of the representative shall be appropriate to the technical requirements of the installation. The qualifications of the representative shall be submitted to the owner for approval. The decision of the owner concerning the appropriateness of the representative shall be final. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Construction Manager shall submit to the Architect/Engineer a signed statement from each representative certifying as follows: **"I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized manufacturer's representative and is properly installed and operating in accordance with the manufacturer's recommendations."**

B. Check inspections shall include plumbing equipment, insulation, controls and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.37 TESTS

A. The Construction Manager shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association, ASTM, etc. Standards listed. The Construction Manager shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests that follow beneficial occupancy by the Owner will be borne by the Owner.

B. Additional tests specified hereinafter under the various specification sections shall be made.

C. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other specification requirements requiring action on the part of the Construction Inspector. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

D. Maintain Log of Tests as hereinafter specified.

E. See specifications hereinafter for additional tests and requirements.

1.38 LOG OF TESTS

A. All tests shall have pertinent data logged by the Construction Manager at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." All Test Log entries shall be legibly signed by the Project Construction Manager or his authorized job superintendent.

1.39 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.40 CLEANING AND PAINTING

A. All equipment, piping, insulation, etc., furnished and installed in exposed areas under Division 22 of these specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification.

B. All purchased equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, CPVC and PVDF.

C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metalwork shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

D. Color of finish painting in Mechanical Rooms shall be painted in accordance with The University of Texas Standard Color Schedule for machinery spaces using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. For painting purposes, the equipment and piping inside of built-up air handling units shall be painted the same as if they were within the walls of a Mechanical Room. Two coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L" PAINT NUMBER
Equipment Bases	Light Green	YG493M (Winter Pear)
Equipment	Green	YG511Y (Biscay Green)
Piping (Insulated and Uninsulated)	Light Gray	B798M (London Fog)
Hanger Rods	Same as "Piping" above	
Metal Exposed to High Temperatures	Same as "Piping" above, high temp rated	
Atmospheric Relief Line	Same as "Piping" above	
Valve Hand Wheels	Blue	B726M (Siam Blue)
Pump Couplings and Fuel Gas Piping (including natural gas, LPG, etc.)	Safety Yellow	Y361M (Daisy Yellow)
Fire Protection Equipment and Piping	Safety Red	R131R (Vibrant Red)

NOTE THAT THE PAINT SPECIFIED ABOVE IS INCLUDED FOR PURPOSES OF ESTABLISHING A QUALITY THAT SHALL BE USED ON THIS PROJECT. THE PROPOSED PAINT SHALL BE SUBMITTED, AND ALTERNATIVES WILL BE CONSIDERED USING THE SUBMITTAL PROCEDURES SPECIFIED IN THIS DOCUMENT.

E. Jacketing on insulation shall not be painted.

F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

G. Scope of painting for Divisions 22--work in areas other than those defined as "exposed" is as follows:

1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers in underfloor spaces shall be cleaned and painted with two coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.

2. All fuel piping (natural gas, LPG, etc.) piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fuel piping shall be painted safety yellow, and fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA.

3. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

H. In addition to painting in mechanical rooms, materials, piping, plumbing, supports, foundations, equipment and appurtenances installed by the subcontractors in exposed areas shall be finish painted with two coats of Pratt and Lambert, Inc.'s "Effector" enamel of color selected by the Architect/Engineer.

I. Additional areas to be defined as "exposed" for purposes of painting, are defined as follows: (Note that paragraph 1.3.10 of this section defines exposed areas for the balance of the project. The areas listed below are to be painted in addition to exposed areas as previously defined.)

J. The surfaces to be finish painted shall first be prepared as follows:

1. On canvas finishes pretreat as specified above. Insulated surfaces having vapor barrier jacket exposed to view shall first be painted with one (1) coat of sealer.

2. Galvanized and black steel surfaces shall first be painted with one (1) coat of P&L galvanized metal primer. Primer may be eliminated on concealed fire and gas piping.

3. Aluminum surfaces shall first be painted with one (1) coat of P&L zinc chromate primer. (See Section 1.51.5)

4. Cast iron pipe shall first be primed with a "non-bleed" primer.

5. ll plumbing systems shall be painted to match architectural and structural systems in exposed area except fire protection and gas systems which shall be painted with their safety system colors.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

C. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by plumbers skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

D. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be supplies by a non-domestic manufacturer provided they fully comply with Contract Documents.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.2 NAMEPLATES

A. Each major component of equipment shall have a manufacturer's nameplate, address, and model number on the nameplate, securely attached to the equipment. All data on nameplates shall be legible at the time of Final Inspection.

B. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

C. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.

1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.3 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes, passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.

B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.

C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

2.4 ROOF PENETRATIONS AND FLASHING

A. Pipe sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 - EXECUTION

3.1 PIPE PRESSURE TESTS

A. The following lines shall be tested at the stated pressure for the length of time noted:

Testing Service	Testing Medium	Pressure (PSIG)	Time in Hours
Domestic Hot & Cold-Water	Water	150	24
Sanitary & Storm Piping	Water	Fill to top	24

B. Where leaks occur, the pipe shall be repaired, and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

3.2 PREPARATION

A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

C. Space Requirements:

1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

D. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.3 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

D. All pipe, shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping.”

2. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All plumbing work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager’s Construction Inspector(s) and the Project Manager, Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

3. The purpose of this inspection is to verify the completeness and quality of the installation of the plumbing systems, and any other special above ceiling systems such as vacuum systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

4. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days or as agreed by owner prior to the inspection.

F. Precedence of Materials:

1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.

2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":

a. Building lines

b. Structural members

c. Structural support frames supporting ceiling equipment

d. Electric tracked vehicle system

e. Pneumatic trash and linen system

f. Pneumatic tube system

g. Soil and drain piping

h. Vent piping

i. Supply, return and outside air ductwork

j. Exhaust ductwork

k. HVAC water and steam piping

l. Condensate piping

m. Fire protection piping

n. Domestic water (cold and hot, softened, treated)

o. Electrical conduit

3. Coordinate fire suppression, plumbing and HVAC systems with transport systems as required to maintain transport system right-of-way.

3.4 TESTING

A. The Contractor shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests that follow beneficial occupancy by the Owner will be borne by the Owner.

B. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.

C. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." All Test Log entries shall be legibly signed by the Project Contractor or his authorized job superintendent.

D. Notify the Project Manager and the Architect/Engineer in writing at least five days calendar days or as agreed by owner prior to each test and prior to other Specification requirements requiring the Project Manager and Architect/Engineer to observe and/or approve tests.

E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results an other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

F. The Construction Inspector shall be notified in writing at least 5 working days or approved by owner prior to each test and other specification requirements requiring action on the part of the Construction Inspector. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

G. Maintain Log of Tests as hereinafter specified.

H. See specifications hereinafter for additional tests and requirements.

I. Refer to Commissioning Specification Sections for additional Start-up, prefunctional and operational checkout, and for functional performance test procedures.

3.5 TRAINING

A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled "Project Closeout Procedures."

B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION 22 00 00

SECTION 22 05 13 – PLUMBING MOTORS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Basic Plumbing Requirements

B. Section 22 05 29 – Plumbing Supports and Sleeves

C. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Single phase electric motors

B. Three phase electric motors

C. The Contractor shall provide all motors required for equipment supplied under this Division of the work

1.3 RELATED WORK

A. Section 22 11 23 - Plumbing Equipment

B. Section 22 13 16.A - Plumbing Specialties

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators

D. ANSI/NEMA MG 1 - Motors and Generators

E. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

A. Submit product data under provisions of Section 22 00 00

B. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.

C. Submit manufacturer's installation instructions under provisions of Section 22 00 00

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 22 00 00

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 22 00 00.

B. Store and protect products under provisions of Section 22 00 00.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY

A. Provide five year manufacturer's warranty under provisions of Section 22 00 00.

B. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Electrical Service: Refer to Drawing schedules for required electrical characteristics.

C. Design for continuous operation in 40 degrees C environment and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor and motor enclosure type.

1. Open Drip-proof Motors: Design for a service factor of 1.15 and a 90 degrees C temperature measured above 40 degrees C room ambient .

2. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.

D. Visible Stainless Steel Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer’s name and model number, Service Factor, Power Factor, efficiency.

E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame. Provide adequately sized metal electrical connection box for conduit connection.

F. Motors shall be built in accordance with the latest ANSI, IEEE and NEMA Standards and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled and of approved manufacturer as listed below or of the same manufacturer as the equipment which they serve. Nameplate rating of motors shall match the characteristics scheduled.

G. All motors shall be designed for normal starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

H. All motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

I. Dynamic Balance shall be no greater than the vibration limits of the driven equipment as defined in the specifications.

J. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

2.2 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with drip-proof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Enclosures shall be of the open drip-proof type with a service factor of 1.15 (motor shall not run in Service Factor under normal operating conditions), and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage high efficiency induction type with standard NEMA frame sizes.

C. Motors 1 HP and larger shall have integral frames.

D. Starting Torque: Between one and one and one-half times full load torque.

E. Starting Current: Six times full load current.

F. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B Characteristics.

G. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.

H. Insulation System: NEMA Class B or better.

I. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.01J.

J. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

K. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 26.Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory pre-packed with a non-detergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for L-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: Refer to ANSI/NEMA MG 1.

M. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

N. Weatherproof Epoxy Sealed Motors (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

O. Nominal Efficiency: Meet or exceed values per 22 05 13-3.03 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

P. Nominal Power Service Factor: Meet or exceed values per 22 05 13-3.02 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

Q. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

R. Motors smaller than 10 hp shall be provided with shaft grounding device when operated by a VFD.

S. Motors 10hp and larger shall be inverter duty rated and shall be provided with shaft grounding device.

2.6 STARTING EQUIPMENT:

A. Each motor shall be provided with proper starting equipment. This equipment, unless hereinafter specified or scheduled to the contrary, shall be provided by the trade furnishing the motor. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted. The Mechanical Subcontractor shall furnish all starters for Division 23 work, except those starters scheduled to be provided in Division 26.

B. Motor starters shall conform to NEMA Standards for Industrial Control, #IC-1, latest issue, and shall be housed in NEMA Standard enclosures. Control voltage in each starter shall be not more than 120 volts to ground, with an individual control transformer provided in each starter as required. Manual starters for fractional horsepower single-phase motors shall be on-off or snap switch type combined with thermal overload device. The switch shall be so constructed so that it cannot be held closed under a sustained motor overload.

C. Magnetic starters shall have thermal overload protection in each of the ungrounded legs and shall be solenoid operated. Provide the correct size heater element to protect the motor and allow it to operate based on motor nameplate amperes and ambient temperatures anticipated for each individual motor. Each starter shall be provided with a control power transformer or 120v control power circuit.

D. Pushbuttons with or without pilot lights, hand-off-automatic switches and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled, and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

E. Hand-Off-Automatic switches for equipment which could damage itself if left in the "hand" position (such as sump pumps), shall be spring return to "off" from the "hand" position.

PART 3 - EXECUTION

3.1 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors shall be energy efficient type.

D. Single phase motors for centrifugal pumps shall be split phase type.

E. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

F. Single phase motors for pumpsshall be capacitor start type.

3.2 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 MOTOR EFFICIENCIES* – NOMINAL, FULL LOAD, THREE PHASE

Minimum Nominal Full Load Efficiency (5) for Motors Manufactured on or after December 19, 2010								
Open Drip-Proof Motors					Totally Enclosed Fan Cooled Motors			
Number of Poles	2	4	6	8	2	4	6	8
Synchronous Speed (RPM) ➔	3600	1800	1200	900	3600	1800	1200	900
Motor Horsepower								
1	NR	82.5	80.0	74.0	75.5	82.5	80.0	74.0

1.5	82.5	84.0	84.0	75.5	82.5	84.0	85.5	77.0
2	84.0	84.0	85.5	85.5	84.0	84.0	86.5	82.5
3	84.0	86.5	86.5	86.5	85.5	87.5	87.5	84.0
5	85.5	87.5	87.5	87.5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	88.5	88.5	89.5	89.5	85.5
10	88.5	89.5	90.2	89.5	89.5	89.5	89.5	88.5
15	89.5	91.0	90.2	89.5	90.2	91.0	90.2	88.5
20	90.2	91.0	91.0	90.2	90.2	91.0	90.2	89.5
25	91.0	91.7	91.7	90.2	91.0	92.4	91.7	89.5
30	91.0	92.4	92.4	91.0	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0	91.7	93.0	93.0	93.0
50	92.4	93.0	93.0	91.7	92.4	93.0	93.0	91.7
60	93.0	93.6	93.6	92.4	93.0	93.6	93.6	91.7
75	93.0	94.1	93.6	93.6	93.0	94.1	93.6	93.0
100	93.0	94.1	94.1	93.6	93.6	94.5	94.1	93.0
125	93.6	94.5	94.1	93.6	94.5	94.5	94.1	93.6
150	93.6	95.0	94.5	93.6	94.5	95.0	95.0	93.6
200	94.5	95.0	94.5	93.6	95.0	95.0	95.0	94.1
250	94.5	95.4	95.4	94.5	95.4	95.0	95.0	94.5
300	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
350	95.0	95.4	95.4	NR	95.4	95.4	95.0	NR
400	95.4	95.4	NR	NR	95.4	95.4	NR	NR
450	95.8	95.8	NR	NR	95.4	95.4	NR	NR
500	95.8	95.8	NR	NR	95.4	95.8	NR	NR

RE: ANSI/ASHRAE/IES Standard 90.1-ZD10, Table 10.8c minimum nominal full-load efficiency of general purpose electric motors (subtype 11 and design 13)

1. *Reference NEMA MG 1-2006 Table 12-12.

END OF SECTION 22 05 13

SECTION 22 05 29 – PLUMBING SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Basic Plumbing Requirements

B. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.3 RELATED SECTIONS

A. Section 03300 - Cast-In-Place Concrete: Equipment bases

B. Section 07 84 00 - Firestopping: Joint seals for piping and duct penetration of fire rated assemblies

C. Section 09 91 00 – Painting

D. Section 22 05 48 – Plumbing Vibration Isolation

E. Section 22 07 19 – Plumbing Insulation

F. Section 22 11 23 – Plumbing Equipment

G. Section 22 13 16 – Plumbing Piping

1.4 REFERENCES

A. ASME B31.1 - Power Piping

B. ASME B31.2 - Fuel Gas Piping

C. ASME B31.9 - Building Services Piping

D. ASTM F708 - Design and Installation of Rigid Pipe Hangers

E. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer

F. MSS SP69 - Pipe Hangers and Supports - Selection and Application

G. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of plumbing and piping.

B. Supports for Sprinkler Piping shall be in conformance with NFPA 13.

C. Support for Standpipes. Shall be in conformance with NFPA 14.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

A. Hangers and Supports:

1. Anvil International.

2. Kinder.

3. Unistrut.

B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided.

D. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

E. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

F. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

G. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

H. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.

I. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

J. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Anvil Fig. CT-65, adjustable, copper plated, clevis hanger. Hangers supporting and contacting brass or copper lines 4" and larger shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Anvil Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.

K. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8" diameter pipe or smaller in size and supporting all ferrous lines 6" and smaller in size shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

L. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

M. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

N. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support shields as specified in Section 22 07 19 - PLUMBING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.

O. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Anvil Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two-hole rigid pipe clamps at 4 ft. o.c. or steel framing channels and Anvil Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators (see Section 22 05 48 – Plumbing Vibration Isolation). Where brass or copper lines are supported on trapeze hangers or steel framing channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

P. Supports for vertical piping in exposed areas shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use a Anvil No. 595 Socket Clamp with Anvil No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

Q. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

R. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

S. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping that may vibrate and create an audible noise shall also be isolated. Spring hangers or supports shall be provided where indicated on the Drawings and/or specified under Section 22 05 48.

T. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:

a. Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.

b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.

c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.

d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.

e. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

g. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.

h. Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

U. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Cooper B-line, Uni-Strut, Power Strut, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

V. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be Zinc-electroplated, galvanized or copper-electroplate finish. Universal concrete inserts shall be cadmium plated.

W. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

2.3 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: 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. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.4 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized steel.

B. Metal Counterflashing: 22 gauge galvanized steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

E. Curbs: Welded 18 gauge galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, factory installed wood nailer.

2.5 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS"):

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with Carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

2.6 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.7 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.

2. Sleeves through interior walls to be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link-seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled for rated wall and/or floor penetrations as specified in Division 7 Section - Fire Stop Systems.

C. Sleeves for penetrations passing through walls and floors on or below grade shall not be removed. Install with mechanical seal system (link seal). Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

D. Vermin proofing: The open space around all, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

E. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

F. Air Plenums: The space around piping, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide 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 over 4 inches.

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 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

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 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple 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. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.

L. Hanger Rods: (NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.)

3.4 FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor and mop sink drains watertight to adjacent materials.

E. Provide acoustical lead flashing around pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

F. Provide curbs for roof installations 14 inches minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing equipment and lap base flashing on roof curbs. Flatten and solder joints.

G. 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.

3.5 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Insure sleeves extend through floors (except in stairwells) two inches above finished floor level andsleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where exposed piping penetrates floor, ceiling, or wall, close space between pipe and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.6 PIPE SUPPORT SCHEDULES

STEEL PIPE SIZE Inches	MAX. HANGER SPACING Feet	HANGER ROD DIAMETER Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1
PP, PVDF, PVC, CPVC (All Sizes)	4	3/8
C.I. Bell and Spigot (or No-Hub), and at all Joints	5	5/8

END OF SECTION 20 05 29

SECTION 22 05 48 – PLUMBING VIBRATION ISOLATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. 22 00 00 -- Basic Plumbing Requirements

B. 22 05 29 – Plumbing Supports and Sleeves

C. 22 05 53 – Plumbing Identification

1.2 WORK INCLUDED

A. Inertia bases

B. Vibration isolation

1.3 SCOPE OF WORK:

A. Furnish and install all labor, materials, equipment tools and service and perform all operations required in connection with or properly incidental to the construction of complete system of vibration and noise control, as indicated on the Drawings, reasonably implied therefrom or as specified herein, unless specifically excluded.

1.4 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves

1.5 QUALITY ASSURANCE

A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 22 00 00.

B. Indicate inertia bases on shop drawings.

C. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.

D. Submit manufacturer's installation instructions under provisions of Section 22 00 00.

1.7 INTENT OF RESPONSIBILITY:

A. It is the intent of this specification to provide for vibration isolation supports for all equipment, and piping as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria, and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Concrete housekeeping pads and inertia bases shall be included as part of plumbing work. The concrete work shall meet the requirements specified in the General Contract Specifications.

C. The Contractor shall furnish complete submittal data, including product schedule, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

D. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN FEATURES:

A. Vibration isolation devices shall be as manufactured by Amber/Booth Company, Consolidated Kinetics, Korfund Dynamics Corporation, or approved equal.

B. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.

C. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cad-plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

D. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.

E. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.

F. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

G. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".

H. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

I. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

2.2 ISOLATOR TYPES:

A. Isolator types and required deflections are specified under "Schedule of Isolated Equipment," paragraph 3.02. The isolators shall comply with the following descriptions for each type required on the project:

B. Type 1 - An elastomeric mounting having steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric materials. The elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives. Mountings shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

C. Type 2 - A pad-type mounting consisting of two layers of 3/8" thick, ribbed or waffled, Neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi load, or a deflection of 0.10" to 0.16".

2.3 FLEXIBLE PIPING CONNECTIONS AT PUMPS:

A. Unit should be rated at 225 psi and a maximum temperature of 230°F.

B. Provide 150 lb. flanges and galvanized aircraft cable control units.

C. Provide flexible connectors at domestic water pressure booster pumping package. Provide flex connectors on pump inlets and discharge flanges. Provide type 304 stainless steel corrugated hose and braid with class 150 lb. floating stainless steel flanges, rated for a minimum of 190 psi at 70°F, for domestic water service, manufactured by Mason Industries Model No. FFLSS, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for 1-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2-inch clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

D. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, to be mounted on the scheduled vibration isolator type to prevent the transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After the piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. The isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length which will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load.

E. Piping:

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights, and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

F. Resilient Sleeves:

1. Resilient sleeves shall be provided at all points where equipment room walls, floors, or ceilings are penetrated by piping.

3.2 SCHEDULE OF ISOLATED EQUIPMENT:

A. Tabulated below is a schedule of equipment on this project requiring vibration isolation and base isolators of the types listed above. Any equipment, system, construction or condition that may be altered, added, or changed; or that is not specifically considered herein or on the plans shall be treated in a manner that is set out for similar equipment system or construction in order to comply with the above requirements heretofore cited.

Equipment Type	Isolator Type/Minimum Deflection (Inches)
Pumps up to 5 HP	Type 1-0.5”
Pumps 5 HP	Type 1-1”
Pumps 10 HP	Type 1-2”
Vacuum Pumps	Type 1-1”

END OF SECTION 22 05 48

SECTION 22 05 53 – PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Basic Plumbing Requirements

B. Section 22 05 29 – Plumbing Supports and Sleeves

1.2 SECTION INCLUDES

A. Nameplates

B. Tags

C. Stencils

D. Pipe Markers

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 22 63 13 – Medical Gas Systems: Supply of pipe labels for placement by this Section

1.4 RELATED SECTIONS

A. Section 09 91 00 – Painting: Identification painting

1.5 REFERENCES

A. ASME A13.1 – Scheme for the Identification of Piping Systems

1.6 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified of implied in the specification.

F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 00.

B. Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 GENERAL

A. The contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the drawings. For example, pumps will be identified as 3a, 3b, 3c, etc.

2.2 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

B. Manufacturers:

1. Seton Identification
2. Brady Corporation
3. Marking Services

2.3 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.

B. Metal Tags: Stainless Steel with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter] with smooth edges.

C. Chart: Typewritten letter size list in anodized aluminum frame.

D. Manufacturers:

1. Seton
2. Identification Products
3. Brady Corporation
4. Marking Services

2.4 PIPE MARKERS

A. Color: Conform to ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

D. Manufacturers

1. Seton Identification Products

2. Brady Corporation

3. Marking Services

2.5 CEILING TACKS

A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

B. Color code as follows:

1. Green - Plumbing valves

C. Manufacturers

1. Seton Identification Products

2. Brady Corporation

3. Marking Services

2.6 PLUMBING EQUIPMENT

A. Equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

PumpsTanks	WATER TANKS
Water Heaters	Miscellaneous - similar
Panels and Switches	and/or related items

2.7 PIPING: PIPE MARKERS AND ARROW MARKERS ALSO SHALL BE PROVIDED ON BUT NOT LIMITED TO THE PIPING OF THE FOLLOWING SYSTEMS:

Domestic Hot Water Return	Domestic Cold Water Supply	Overflow Drain
Condensate Drainage		
Tempered Water		

2.8 VALVE TAGS:

A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10' and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8" thick brass discs, 1 1/2" in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

B. Valves at water headers PRV stations, valves associated with gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2" wide by 1 1/2" high with these color codlings: Red = normally closed; Green = normally open; Tags should be engraved on both sides.

C. In addition, pipe runs throughout the building including those above lift out ceilings, under floor, and those exposed to view when access doors or access panels are opened shall be identified by means of Seton Setmark or Brady Mechanical Pipe Markers. Concealed areas, for purposes of this identification section, are those areas which cannot be seen except by demolition of the building elements. In addition to the pipe markers, arrow markers shall be used to indicate direction of flow. The following specific instructions shall apply to the application of these markers:

D. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one header, it is necessary to mark only the header.

E. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

F. Provide a double ended arrow marker when flow can be in either or both directions.

G. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.

H. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.

I. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.

J. Use snap-on type identification for all piping systems, 3/4" thru 6". For piping systems larger than 6", use strap on markers.

K. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems." Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

L. Locate markers to be visible from floor.

2.9 SPECIALS:

A. Refer to special requirements noted in the various sections hereinafter bound.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 9 for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Division 9.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

F. Identify pumps, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify valves in main and branch piping with tags.

I. Provide ceiling tacks to locate valves or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 22 05 53

SECTION 22 07 19 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. 22 00 00 -- Basic Plumbing Requirements

B. 22 05 29 – Plumbing Supports and Sleeves

C. 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Piping insulation

B. Jackets and accessories

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 22 13 16- Plumbing Piping: Placement of hangers and hanger inserts.

1.4 RELATED SECTIONS

A. Division 9 - Painting

1.5 REFERENCES

A. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate.

B. ASTM C177 Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

C. ASTM C195 Mineral Fiber Thermal Insulation Cement.

D. ASTM C335 Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

E. ASTM C449 Mineral Fiber Hydraulic setting Thermal

F. ASTM C518 Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

G. ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C547 Mineral Fiber Preformed Pipe Insulation.

J. ASTM C552 Cellular Glass Block and Pipe Thermal Insulation.

K. ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation.

L. ASTM C585 Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

M. ASTM C921 Properties of Jacketing Materials for Thermal Insulation.

N. ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.

O. ASTM D2842 Water Absorption of Rigid Cellular Plastics.

P. ASTM E84 Surface Burning Characteristics of Building Materials.

Q. ASTM E96 Water Vapor Transmission of Materials.

R. NFPA 255 Surface Burning Characteristics of Building Materials.

S. UL 723 Surface Burning Characteristics of Building Materials.

T. ASHRAE 90.1 – Energy Standard for Buildings Except Low Rise Residential Buildings

1.6 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Product Data: Provide product description, list of materials 'k' value, 'R' value, mean temperature rating, and thickness for each service, and locations.

C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.7 QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84 89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 22 00 00.

C. All piping shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.

1.8 QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years' experience specializing in the trade.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 22 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

C. All insulation materials to be asbestos free.

PART 2 - PRODUCTS

2.1 DOMESTIC HOT AND COLD WATER

A. All domestic hot and cold water lines in buildings, including valves, strainers, unions, flanges, etc., except where specifically noted to the contrary, shall be insulated.

B. All domestic cold water lines shall be insulated as scheduled with preformed fiberglass insulation with a factory applied All Service Jacket, vapor sealing all joints, and factory performed fittings with vapor seal, or a flexible, "25-50" rated, closed cell elastomeric thermal insulation such as "Self Seal Armaflex 2000". Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint. All elastomeric insulating products shall be guaranteed not to react with copper piping. Valves shall be insulated with mitered pipe covering with voids filled with glass fiber blanket insulation. Valves and fittings shall be vapor sealed with a water base asphaltic emulsion. Fittings on concealed insulation shall be built up to the thickness of adjacent insulation with glass fiber fitting wrap and shall be finished with Glasfab tape embedded in vapor barrier emulsion. Exposed fitting insulation shall be built up to same thickness as adjoining pipe insulation with one coat cement and after drying shall be finished with a white vapor seal and canvas jacket secured with "Arabol" adhesive and be suitable for painting. Seams in jacket shall be placed in the least noticeable locations. Where seams, joint or fittings are rough they shall be covered with an application of insulating cement troweled on smoothly before the canvas is applied with Arabol adhesive. The canvas must be free of wrinkles and have a smooth, neat appearance.

C. All domestic hot water piping systems shall be insulated as specified above for cold water except the vapor barrier may be deleted and the lap and butt joints secured with staples and a field applied adhesive (self sealing lap and butt joints alone are not acceptable). The insulation thickness shall be as scheduled. Where service temperature exceeds 250°F, insulation shall contain high temp binders.

D. The only domestic hot and cold water piping that will not require insulation is the exposed runouts under non-handicap plumbing fixtures. Where pipe chases are tight, adequate provision shall be made at the rough in stage utilizing offset fittings or other means (except springing the pipe) to insure that insulation can be applied throughout the length of the pipe.

2.2 ROOF DRAIN AND OVERFLOW DRAIN PIPING

A. All horizontal runs of roof drain piping in the building, and the bottom of all roof drains shall be insulated and sealed to the roof. Insulation shall be as specified for domestic cold water. Vertical roof drain piping inside the building shall not be insulated.

2.3 CONDENSATE DRAINAGE AND WATER RECOVERY.

B. All piping receiving condensate drainage and water recovery shall be insulated, as specified herein.

2.4 TYPE A: FIBERGLASS

A. Owens Corning or equal glass fiber insulation piping insulation with a “K” factor of 0.23 BTU-In/Hr.-degree F at 75°F and 0.32 BTU-In/Hr.-degree F at 250°

1. Rated maximum service temperature of 850°F.

2. Maximum density of 3.5-5.5 lbs/ft^3

3. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.

4. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.

5. Certified to meet the requirements of ASTM C795 for use over stainless steel.

6. Rated as noncombustible when tested in accordance with ASTM E136.

7. Insulation treated with water resistant resin on the surface and within each layer of the insulation

2.5 TYPE B: CLOSED CELL ELASTOMERIC

A. Closed cell elastomeric piping insulation with a “K” factor of 0.25 BTU-In/Hr.-degree F at as manufactured by Armacell or equal.

1. Rated maximum service temperature of 220°F.

2. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.

3. Certified to meet the requirements of ASTM C795 for use over stainless steel.

4. Rated as noncombustible when tested in accordance with ASTM E136.

2.6 PROTECTIVE JACKETING

A. Aluminum Jacketing and fitting covers:0.016 aluminum smooth as manufactured by Premetco or Childers. The jacket shall be pre-cut, pre-rolled, and lapped a minimum of two inches (2") In all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.) ¾" wide .020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016" aluminum or stainless steel with a smooth finish.

B. PVC Jacketing: Proto Corp. LoSmoke PVC jacketing and fitting covers Material shall have 25/50 rating and shall be limited to piping systems operating at 140 degrees or below.

PART 3 - INSTALLATION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions in the absence of specific instruction herein.

B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the "90°" position, with the seam lapped such that the lap is directed down.

C. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

D. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

F. For piping systems being heat traced, provide insulation one pipe size larger to accommodate the heat tracing cable.

3.3 INSERTS, SUPPORTS AND SHIELDS

A. Application: Piping 3/4 inch diameter or larger for all systems.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for insulated pipes 3/4" and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS	Metal Thickness of Shield	Lengths
up thru 2”	14 gauge	12”
thru 6”	12 gauge	16”
and above	10 gauge	20”

C. Insert Location: Between support shield and piping and under the finish jacket.

D. Insert Configuration: Minimum 2” inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

F. The shields at support points shall be secured with ½” x 0.016” stainless steel bands and seals.

G. Finish insulation at supports, protrusions, and interruptions.

H. In lieu of the above the following system of support may be used:

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft3 INSUL-PHEN Foam material to withstand the bearing loads transmitted from the pipe to the support, it shall extend for at least 1" on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1" thickness of 2.2 lbs/ft3 standard insulation including FSK/ASJ vapor barrier.

I. Table 1 K Block Support Centers

Nominal Pipe Size	3/4	1	1 1/4	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24
Max support centers (feet) Sch 80 pipe filled with water covered with 1" of Standard Insulation	6.5	6.5	6.5	10	10	10	10	10	14	14	14	20	20	20	20	20
Metal Saddle Gauge (Galvanized Steel)	22	22	22	20	20	20	16	14	14	14	14	14	114	14	14	14
Length of K Block (inches)	6	6	6	6	6	6	6	9	9	9	9	9	9	12	12	12

1. The Insulation at supports shall be a Kooltherm K Block. K Blocks shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel 1800 saddle bonded to the bottom section of the K Block, for all pipe sizes 1 1/2" and larger.

2. The vapor barrier shall be completed by the use of a FSK/ASJ overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

3. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval. e.g. Of the type Kooltherm products K Block. Ref:-Kooltherm sketch 106/2c for use with Roller or flat beam support.

4. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

J. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

K. Self-Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.

L. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140 degrees F on the hot surfaces.

M. All insulated piping in the mechanical rooms within 8'-0" of the floor shall be encased in an aluminum protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

N. All piping with crawl space, outside building and in tunnels shall be protected with an aluminum jacket.

3.4 PAINTING

A. All exposed insulation shall be prepared to receive painting specified under Section 09 91 00.

3.5 INSULATION APPLICATION SCHEDULE

B. Where minimum scheduled thickness exceeds the thickness required to meet the minimum R-Value, provide the minimum scheduled thickness.

Service	Pipe Diameter Inches	Location	Fluid Temp Degrees F	Min. R-Value	Insulation Type and Thickness in Inches	
Domestic Cold WaterAnd Makeup Water	All Sizes	Interior	Ambient	4.2	Type A 1	Type B 1
Domestic Cold Water and Domestic Hot Water	All Sizes	Interior, Serving	Ambient	2.1	Type A 1/2	Type B 1/2

		Single Fixtures				
Domestic Hot Water Supply & Return	1 to 1-1/4	Interior	105-140	4.2	Type A 1	Type B 1
Domestic Hot Water Supply & Return	1-1/2 and up	Interior	105-140	6.4	Type A 1-1/2	Type B 1-1/2
AHU Drains	All Sizes	Interior	Ambient	4.2	Type A 1	Type B 1
Drinking Fountain Drains	All Sizes	Interior	40-55	4.2	Type A 1	Type B 1
Floor Drain Bodies Receiving AHU Condensate Including P-Trap and a Minimum 20' of Pipe	All Sizes	Interior	40-55	4.2	Type A 1	Type B 1
Floor Drain Bodies Receiving AHU Condensate Including P-Trap and a Minimum 20' of Pipe	All Sizes	Tunnel, Outside, in Crawl Space	40-55	2.9	Type A 1	Type B 1
Roof Drain and Overflow Drain Bodies and horizontal Piping Extending to Vertical Downspout	All Sizes	Interior	Ambient	4.2	Type A 1	Type B 1

1. All insulation R-Values shall be the greater of what is scheduled above or required to meet ASHRAE 90.1-2010.

2. Minimum 'R' does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

3. A minus 15 percent tolerance, on the insulation performance listed shall be permitted for manufacturers' standard insulation systems.

4. In non-conditioned mechanical rooms and all crawl spaces, insulation shall prevent formation of surface condensation under conditions of 95°F, 95%RH, and zero wind speed. Provide manufacturer's certification of this performance on submittal data.

END OF SECTION 22 07 19

SECTION 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for Plumbing systems, assemblies, controls, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

1.2 RELATED SECTIONS

A. SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

B. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

C. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

1.3 DEFINITIONS

A. Refer to SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.4 SUBMITTALS

A. Certificate Of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for details of Plumbing contractor’s responsibilities related to commissioning.

B. Perform commissioning tests at the direction of the CxA.

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

F. Functional testing of systems will be carried out solely by Plumbing contractor's personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.6 CxA'S RESPONSIBILITIES

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 22 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.

C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that testing, adjusting, and balancing procedures for Plumbing systems have been completed and submitted, discrepancies corrected, and corrective work approved.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.4 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Plumbing systems.

B. Provide measuring instruments to record test data as directed by the CxA.

3.5 PIPING SYSTEMS

A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.6 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.7 RE-TESTING

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Plumbing systems.

3.8 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for list of Plumbing systems to be commissioned.

END OF SECTION

SECTION 22 11 23 – PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Basic Plumbing Requirements

B. Section 22 05 29 – Plumbing Supports and Sleeves

C. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Water Heaters

B. Pumps

C. Domestic Water Pressure Booster System

1.3 RELATED SECTIONS

A. Section 22 05 48 - Vibration Isolation

B. Section 26 05 19 - Insulated Conuctors: Electrical characteristics, cable, wire, materials

C. Section 26 27 26 - Wiring Devices: Wiring connections

1.4 REFERENCES

A. ANSI/ASHRAE 90A - Energy Conservation in New Building Design

B. ASME Section VIIID - Pressure Vessels; Boiler and Pressure Vessel Codes

C. ANSI/NFPA 30 - Flammable and Combustible Liquids Code

D. ANSI/NFPA 54 - National Fuel Gas Code

E. ANSI/NFPA 58 - Storage and Handling of Liquefied Petroleum Gases

F. ANSI/NFPA 70 - National Electrical Code

G. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters

H. ANSI/UL 174 - Household Electric Storage Tank Water Heaters

I. ANSI/NEMA 250 - Enclosure for Electrical Equipment (1000 Volts Maximum)

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Shop Drawings:

1. Include heat exchanger dimensions. size of tappings, and performance data.

2. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

C. Product Data:

1. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

2. ndicate pump type, capacity, power requirements, and affected adjacent construction.

3. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

4. Provide electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 00.

B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with State of Texas Department of Health Standards.

B. Provide pumps with manufacturer's name, model number, and rating/capacity identified.

C. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF).

2. American Society of Mechanical Engineers (ASME).

3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).

4. National Electrical Manufacturers' Association (NEMA).

5. Underwriters Laboratories (UL).

D. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 10 percent of midpoint of published maximum efficiency curve.

1.8 REGULATORY REQUIREMENTS

A. Conform to AGA, NSF, ANSI/NFPA 54, ANSI/NFPA 58, ANSI/NFPA 70, ANSI/UL 174, and ANSI/UL 1453, as appropriate, requirements for water heaters.

B. Conform to ASME Section VIIID for manufacture of pressure vessels for heat exchangers.

C. Conform to ASME Section VIIID, ANSI/NFPA 30, or ANSI/NFPA 31 for tanks.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 00.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.10 WARRANTY

A. Provide five-year warranty under provisions of Section 22 00 00.

B. Warranty: Include coverage of domestic water heaters, water storage tanks, packaged water heating systems, in- line circulator, submersible sump pumps, sump pumps, sewage ejectors.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATERS

A. Provide commercial type electric powered water heater with integral storage tank compliant with UL 1453. Unit shall be UL listed pre-wired, factory tested complete with tank drain valve and ASME rated temperature and pressure relief valve. Refer to drawings for recovery rate, storage capacity, electrical demand and dimensions.

B. Storage tank shall be constructed to Section 4 of ASME Code for 125 psi working pressure. Storage tank shall be internally glass lined with high density magnesium anodic protection. The tank shall be factory insulated with fiberglass insulation with enamel steel jacket to meet the thermal efficiencies of ASHRAE 90A.

C. The water heater shall have a 120 volt control circuit powered by fused transformer, immersion temperature control adjustable through a range of 60 degrees F to 180 degrees F, with a manual reset high temperature cut-off switch and temperature limiting device with automatic reset.

D. Provide water heaters as manufactured by A.O Smith, Bradford White, Rheem or State.

2.2 DOMESTIC HW CIRCULATION PUMPS

A. These pumps shall be Bell and Gossett, Taco or Grundfos (magnetic coupled) having a circulating capacity as shown on the Drawings. Pumps shall be all bronze construction. Furnish for the control of each pump an Allen Bradley Bulletin 600 Toggle Switch with thermal overload protection and pilot light.

B. Provide electronic timer to control run cycle of circulation pump to cut off pump during periods of building not being occupied for energy conservation. Timer shall be field adjustable, 24 hour a day operation and set point, to cut on/off pump during night, 120 volt single phase, with manual external override, drawn steel case, hinged door, battery backup, UL listed, set points as indicated on the construction drawings. Manufactured by Intermatic Model EH10, or approved equal.

C. Provide aquastat to control on/off function of circulating pump based on required temperature setting of the domestic hot water circulation system, during periods of when timer has not cut off pump. Aquastat shall be pipe mounted with immersion insertion element, single type, field adjustable temperature setting, SPDT type switch, 120 volt single phase power requirement.

2.3 DOMESTIC WATER PUMPING SYSTEM:

A. The domestic water pumping system shall consist of (two) (three) (four) variable speed pumps operated from one automatic control panel. The pumps shall be vertical multistage centrifugal with cartridge seals and a high temperature switch. The package shall conform to NSF61.

B. The variable speed house pump controller shall be of the solid state type, full service type either individually mounted on each pump or individually mounted in control panel. The controller panel shall be of the NEMA 1 design containing fused disconnect switches, running lights and shall be floor mounted. The control panel shall contain such elements as are necessary for variable speed control with all wiring brought to factory wired control strip. The package shall be designed to allow removal and/or repair to one pump without the entire pumping system being taken down. Provide a H-O-A switch for each motor, pump status indicating lights, pump starters, control voltage transformer, adjustable time delay for lag pump start signal and alarm system, intermittent audible alarm horn with silencer and reset delay. Limit switches for high pressure cut-off, low pressure cut-off and low pressure cut-off with alarm, silencing button with automatic reset shall be included. All components shall come completely factory assembled and wired. Auxiliary contacts for signal to DDC system for low suction pressure alarm (1 point), each pump status 2points), pump failure alarm for each pump 2points, shall be included.

C. A time clock alternator shall be furnished which will periodically and automatically interchange the lead and lag variable speed pumps. The time clock alternator shall be furnished inside of the control center.

D. The pump motors shall be designed to be compatible with the solid state controller and operating at an approximate maximum speed of 3450 RPM. Provide TEFC or ODP premium efficiency motor. Motors shall be sized so that nameplate amperage is not exceeded at any point on the pump operating curve. Refer to Section 22 05 13.

E. The system shall be designed so that either pump shall operate and stage on as the system demand increases. When the demand exceeds the capacity of one pump, the second pump shall automatically start and run as long as required to meet the demand. The maximum differential at the pump discharge shall be 10 psi.

F. Provide isolation valves on each pump suction and discharge and a non-slam check valve on each pump discharge. Package water piping shall be stainless steel. All valves shall be threaded full port ball type valves for pipe sizes 2” and smaller or flanged butterfly type valves for pipe sizes over 2”. Locate a pressure gauge at the equipment skid inlet and discharge headers. All fittings shall be flanged or threaded completely lead free.

G. The package shall be designed to allow removal and/or repair to one pump without the entire pumping system being taken down.

H. The variable frequency drives shall be full service type drives and may either be individually pump mounted or mounted in control panel.

I. Provide an ASME coded precharged hydropneumatic expansion tank constructed with a minimum working pressure of 150 psig. Internal wetted parts shall be compliant with FDA regulations and approval for domestic drinking water. The bladder shall be butyl diaphragm separting the air from the water. The tank size shall be determined by the pump skid supplier for the specific project design parameters.

J. Provide pumping system as manufactured by Grundfos, Armstrong, Bell & Gossett, Canariis, or Syncroflo.

2.4 ELEVATOR SUMP PUMPS

A. General: Provide complete and operational elevator sump pumps in accordance with latest elevator code, and as specified herein, as scheduled and as shown on the Drawings.

B. Pumps: The elevator sump pump shall be completely submersible cast iron shell with bronze or thermoplastic impeller, 303 stainless steel shaft and housing, motor shall be hermetically sealed with built-in overload protection, bearings shall be factory sealed grease lubricated ball type. Pump capacities shall be as scheduled on the Drawings.

C. Monitoring Panel: NEMA 4X enclosure, 120 volt single phase, alarm light, water presence visual alarm, silence switch, mounting hardware, complete with all necessary hardware and components to interface with pump to automatically cut on pump presence of 6 inches of liquid in sump and cut off pump upon liquid being pumped down to 2-1/2 inches from bottom of sump. Controls shall not prevent pump from operating, but only monitor pump. Mount in elevator pit accessible from elevator doors. Complete with set of dry contacts to indicate pump status (alarm when pump cuts on) to building automation system.

1. Pump Status (each pump)

2. High Water Alarm.

3. Overflow Water Alarm.

D. Wiring between control panel and pumps shall be the responsibility of this Contractor and coordinated with Division 26.

E. Coordinate all sump pump components with elevator cab clearance. Meet all local and state code requirements.

2.5 WATER SOFTENER

A. Provide twin alternating unit consisting of a non-corrosive fiberglass softening tank with one piece thermoplastic inner liner and a polyethylene brine tank. Unit shall be complete with top mounted integral brass control valves for each tank, automatic self-adjusting brine injector, flow controller, factory wired, water meter initiated regeneration, water hardness test kit, and manual regeneration function. Softening tanks shall be NSF, FDA and UL approved with a minimum 5 year warranty, rated for a 150 psi working pressure. Unit shall have a capacity as scheduled. Provide water softener as manufactured by Unity, Watertech, or Mueller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, and state requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install the water heaters, piping, vents and accessories in accordance with the manufacturer’s published installation instructions.

D. Furnish all supports required by the equipment included in this Contract.

E. Provide a 4" thick, reinforced concrete housekeeping pad beneath heaters and pump skids.

F. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. to facilitate proper functioning and servicing of equipment.

G. Install a line size shutoff valve in cold water inlet and hot water outlet close to each heater.

H. Provide a temperature gauge in the domestic hot water piping within five feet of outlet of each heater, upstream of all shut-off valves. Size and locate gauge to be easily readable from a standing position.

I. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment, such as dielectric coupling or dielectric flange fitting.

J. Pipe relief valves discharge and all equipment drains indirectly to appropriate floor drain.

K. Set the equipment operating and safety controls.

L. Set thermostats on domestic water heaters to deliver maximum water temperature as indicated on Contract Drawings.

M. Coordinate equipment electrical connections with Division 26 requirements. Ground equipment and connect wiring according to Division 26 specified requirements.

3.2 STARTUP

A. Startup shall be performed by factory trained and authorized personnel. The factory representative shall also provide a technical and practical operation and maintenance training seminar including a hands-on operation and maintenance demonstration, and classroom presentation with handouts and visual aids.

END OF SECTION 22 11 23

SECTION 22 13 16 – PLUMBING PIPING

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Basic Plumbing Requirements

B. Section 22 05 29 – Plumbing Supports and Sleeves

C. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Pipe and Pipe Fittings

B. Valves

1.3 RELATED SECTIONS

A. Section 31 23 16 – Excavating

B. Section 31 23 23.13 – Backfilling

C. Section 31 23 16.13 – Trenching

D. Section 33 13 00 – Disinfection of Water Distribution System

E. Section 08 31 13 – Access Doors

F. Section 09 91 00 – Painting

G. Section 22 20 00 – Piping, Valves and Fittings

H. Section 22 05 48 – Plumbing Vibration Isolation

I. Section 22 07 19 – Plumbing Insulation

J. Section 22 11 23 - -Plumbing Equipment

K. Section 22 13 16.A – Plumbing Specialties

L. Section 22 40 00 – Plumbing Fixtures

1.4 REFERENCES

A. See Section 22 20 00

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 00.

B. Record actual locations of valves, etc., and prepare valve charts.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

A. See Section 22 20 00

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum of three years documented experience.

1.10 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

B. Conform to applicable code for installation of backflow prevention devices.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 00.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.12 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.13 EXTRA MATERIALS

A. Furnish under provisions of Section 22 00 00.

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Provide materials as specified herein and indicated on Contract Drawings. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.

C. Pressure ratings of pipe, fittings, couplings, valves, and all other appurtenances shall be suitable for the anticipated system pressures in which they are installed.

2.2 STORM DRAINAGE PIPING SYSTEM

A. General: A complete system of roof storm drain piping including overflow drain system shall be installed as indicated on the Drawings.

B. Pipe and Fittings:

1. All interior downspouts and interior storm drainage piping, and all such piping up to a point five feet (5') outside the building walls, or to any other point indicated on the Drawings, shall be service weight cast iron soil pipe, hub and spigot for pipe ten inch (10") and larger and hubless for eight inch (8") and smaller. All pipe and fittings shall be service weight cast iron marked with collective trade mark of CISPI. Manufactured by Charlotte, Tyler.

2. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer's mark or name cast on it. Where roof drains are higher than 50 feet above the horizontal main drain runout at grade level, all the vertical storm drain piping system 50' below the roof line shall be constructed of standard Schedule 40 black steel pipe with weld fittings.

C. Exterior storm water drainage piping to a point five feet (5') outside building walls or to point shown shall be service weight cast iron sewer pipe. Where piping passes under specific areas noted on Drawings, it shall be service weight cast iron up to fifteen inches (15") in size.

D. Installation of Piping:

1. All piping shall be run in the most direct manner. Horizontal pipes shall have a grade of one-quarter inch (1/4") per foot, wherever possible, and not less in any case than one-eighth inch (1/8") per foot, unless otherwise noted on Drawings.

2. Cleanouts shall be provided at the bottom of each downspout, at each change of direction and at intervals not exceeding 95 feet in horizontal runs. Interior cleanouts shall be brass caulked into the lines, and where they occur in walls or floors of finished areas, shall be provided with nickel-bronze tops or access plates. All interior cleanouts shall be of the same size at the pipe served up to four inch (4") size and four inches (4") for all larger lines.

3. Exterior cleanouts shall consist of a concrete encased wye in the line with sewer pipe extending upward therefrom and terminating in a concrete slab below grade. A standard cast iron cleanout casting shall be set on this slab in such manner as to be flush with finished grade and to provide access through its cover to the cleanout. A removable concrete stopper shall be set in the open top of the cleanout pipe.

4. All storm drain bodies, the first 10' feet of pipe from the drain and all horizontal runs of storm drainage piping within the building, except in crawl space shall be insulated as described in the insulation specifications.

5. All sizes of all underground storm drain piping within the building shall schedule 40PVC.

E. Roof drains and Area Drains:

1. All roof and area drains will be furnished and installed with all accessories required for the particular construction in which they are to be mounted. Area drains shall be as indicated on the Drawings and as specified in other sections.

F. Subsurface Drainage: Excavation to bottom of grade beam is by General Contractor. Final fine grading for sub-soil pipe is by Mechanical Contractor. Material for backfill, twelve inch (12") both sides of pipe and twenty-four (24") above pipe bottom of excavation, shall be furnished by General Contractor and installed by Mechanical Contractor. Additional backfill is furnished and installed by General Contractor. Provide PVC SDR35 perforated pipe with minimum 2 rows of 1/2 inch diameter holes spaced 4 inches on center, parallel to the axis of the pipe, at a maximum 45 degrees apart. Pipe and fittings shall conform to ASTM D1784. Fittings shall be DWV pattern PVC, minimum same thickness as pipe, with socket solvent cement joints, conforming to ASTM D2564. Face pipe perforations in pipe downward in the excavation prepared for drain pipe. Wrap pipe in fabric as detailed on plumbing drawings.

G. Tests: All storm drains shall be tested in vertical sections of approximately 50 feet each by filling leader with water and allowing to stand twenty-four (24) hours. Any leaks discovered shall be repaired and the test repeated. All tests shall be observed by the Owner's representative and the Architect/Engineer before tests are removed.

2.3 SANITARY DRAINAGE SYSTEM

A. General: The sanitary drainage system shall be installed as indicated on the Drawings complete with all fixtures, drains, traps and required connections. All fixtures and drains shall be properly vented and trapped. The Contractor shall complete the installation of the sanitary drainage system by making approved connections as indicated on the Drawings.

B. Pipe and Fittings:

1. All pipe used for interior, above ground sewer and drainage purposes, unless specifically shown to the contrary, shall be service weight cast iron soil pipe. All pipe and fittings shall be service weight cast iron marked with collective trade mark of CISPI. Manufactured by Charlotte, or Tyler.

2. All pipe and fittings from the sump pumps and sewage ejectors shall be Schedule 80 PVC with PVC bolted flange connections at pump discharge and at each valve. PVC piping shall be run from the pumps to the exterior piping connection point within 6" of 5'-0" outside of the building.

3. Galvanized or black steel pipe shall not be used in any waste connection to a fixture or in any section of the soil or waste piping system.

4. All underground sanitary waste piping, of all sizes, shall be schedule 40PVC.

C. Installation of Piping:

1. All piping shall be run in the most direct manner. Horizontal pipes shall have a grade of one-quarter inch (1/4") per foot, wherever possible, and not less in any case than one-eighth inch (1/8") per foot, unless otherwise noted on Drawings.

2. Cleanouts shall be provided at the bottom of each riser, at each change of direction and at intervals not exceeding 95 feet in horizontal runs. Interior cleanouts shall be brass caulked into the lines, and where they occur in walls or floors of finished areas, shall be provided with nickel-bronze tops or access plates. All interior cleanouts shall be of the same size at the pipe served up to four inch (4") size and four inches (4") for all larger lines.

3. Exterior cleanouts shall consist of a concrete encased wye in the line with sewer pipe extending upward therefrom and terminating in a concrete slab below grade. A standard cast iron cleanout casting shall be set on this slab in such manner as to be flush with finished grade and to provide access through its cover to the cleanout. A removable concrete stopper shall be set in the open top of the cleanout pipe.

D. Flashings: All vent pipes passing through the roof shall be provided with roof flashings per Section 22 05 29.

E. Testing:

1. After the vertical lines of soil pipe, waste, and other parts of the sanitary system have been set from the basement to the top of the building, all outlets shall be temporarily "plugged up", except as are required for testing as described herein. One floor level of the building shall be tested at a time. Each floor shall be tested from a level below the structure of the floor, or the outlet of the building in the case of the lowest level, to a level of 12 inches above the floor immediately above the floor being tested, or the top of the highest vent in the case of the highest building level. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 24 hours. If after 24 hours the level of the water has been lowered by leakage, the leaks must be found and stopped, and the water level shall again be raised to the level described, and the test repeated until, after a 24 hour retention period, there shall be no perceptible lowering of the water level in the system being tested.

2. A final test shall be conducted after all vertical and horizontal pipes and "rough-ins" have been complete but before the sewer connection is made. The test procedure shall be identical with that described above except that the entire plumbing system, i.e., the vertical and horizontal pipe and "rough-in", shall be subjected to water under the head imposed by filling the system to the top of the building for buildings two (2) stories and less. For buildings more than two stores, the Contractor can test two stories at a time or use compressed air to test the system, set at 5 psi test pressure. After all testing operations have been completed, all waste lines shall be cleaned.

3. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of the Owner's duly authorized representative. Such tests shall be conducted and completed before any joints in plumbing are concealed or made inaccessible.

F. Fabrication Methods for Sewage and Drainage Pipe Lines:

1. Install promptly all sewers, drains and piping after excavating, chasing or cutting for them has been done to keep the openings for such piping open as short a time as possible. No piping shall, however, be permanently closed up, furred in or covered before the examination of same by the authorities having jurisdiction.

2. Waste pipes shall be sized to conform to the sizes indicated on the Drawings. Under no circumstances shall any drain line be smaller than two inches. The waste pipes from water closets shall not be smaller than four inches.

3. The drilling and tapping of soil or waste lines or the use of saddle joints or the welding or brazing of hubs or pipe to any soil, waste or vent lines is prohibited.

4. Wastes must be brought up directly in back of each fixture. Horizontal branch arms of lead or brass will not be allowed.

5. No waste or soil lines shall enter the vertical part or heel of a lead or cast iron closet bend. Waste lines may enter the horizontal part of the lead or cast iron closet bend. No sink or lavatory waste line shall enter any other waste line of two inch (2") size.

6. All waste connections shall be made of heavy brass threaded nipples or with copper tube with appropriate screw to sweat adapters for connecting to sanitary tee. All fixtures used in connection with the conveying of any waste substance to the sanitary sewer, shall be connected by means of a trap, waste and overflow. Slip joints will be permitted only on the house side of the trap, waste and overflow, or appliance which has such slip joints embodied in their original manufacture. Fixtures which have waste opening connected to the soil or waste lines by the use of bolts or screws shall have such connections made by the use of the exact number of bolts or screws as provided for in their original manufacturer.

7. Where waste and vents are exposed at fixtures, pipes shall be chrome plated brass or brass W.C.P. cover (iron pipe size) and shall have chrome plated escutcheons where they pass through floors, walls, or ceilings.

G. Vents:

1. Vent pipes shall be carried up adjoining soil and waste pipes, and they shall be connected into the main stack at top and bottom as indicated on the plumbing riser diagrams on the Drawings.

2. Vent pipes shall be of hubless service weight cast iron pipe.

3. All vent lines shall be so constructed that they cannot be used for waste or soil lines. No fixture shall be double trapped.

H. Connections to Floor Mounted Water Closets:

1. All connections for floor mounted water closets and waste piping shall be made with an appropriate cast iron closet flange and wax gaskets.

2.4 WATER SUPPLY SYSTEM

A. A complete system of hot and cold water supply to all plumbing fixtures and mechanical equipment shall be supplied and installed as shown on the Drawings. The water supply system shall be installed using the materials and methods as specified in the following paragraphs. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.

B. Underground Water Supply Systems:

1. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 DUCTILE iron pipe arranged with bell and spigot mechanical joints.

2. Fittings: See Section 22 20 00.

3. Valves: See Section 22 20 00.

4. Valve Boxes: For each underground valve installed by the Contractor, the Contractor shall provide and install a two-piece, screw adjustable type valve box. These valve boxes shall be designed for heavy roadway service and they shall have a deep socket type of cover which prevents their being accidentally knocked out of position. The word "**WATER**" shall appear on each cover. The installation of these members shall be such that by the use of the adjustable screw type bodies the tops are just flush with the finished grade. These valve boxes shall be Tyler Pipe Industries #6850, or approved equal.

5. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

C. Irrigation Provisions:

1. Furnish and install capped and/or valved water lines under paving, through retaining walls in paved plaza areas and as indicated on Drawings for connections and extensions under work of Section Irrigation (Sprinkler) System.

D. Building Entrance:

1. A metallic sleeve shall be inserted in the forms of the building wall through which the water service enters the building. The interior diameter of such sleeve shall be four inches (4") greater than the exterior diameter of the water service.

2. The water service pipe from within the building shall be extended to a point three feet outside the building wall through this sleeve. The position of the water service in this sleeve shall be concentric and the intervening space shall be packed in a flexible manner to avert the flow of water from outside of the building into the basement.

3. The interior pipe extended outside the building shall be provided with a protective wrapping of "Tape Coat" SP warmed with hand torch. This protective tape shall be applied with "half-lap" coverage in strict accordance with the manufacturer's published instructions. The cast iron pipe connected to the pipe extending from the building wall shall contain two caulked joints within four feet of the union of the cast iron pipe and the interior pipe from the building.

2.5 INTERIOR DOMESTIC WATER PIPING SYSTEMS:

A. All piping within confines of building walls shall be a part of the interior water piping system. Interior domestic water piping material and installation shall be as specified in the following paragraphs.

B. Pipe:

1. Interior domestic water piping larger than six inches (6") shall be Schedule 40 galvanized steel pipe. See Section 22 20 00. When approved by the Owner in writing, the use of roll-grooved copper pipe may be used. When a roll grooved coupling system is approved for a copper piping system, the couplings shall be ductile iron conforming to ASTM A-536 Grade 65-45-12, coated with copper colored alkyd enamel, similar to Victaulic Style 607. Coupling gaskets shall be Grade “EHP” EPDM compound for operating temperatures of -30 degrees F to 250 degrees F. Flange adapters for copper tubing shall consist of ASTM A-536, Grade 65-45-12 ductile iron housing with copper colored alkyd enamel. Flange adapters shall be manufactured for engaging directly into copper tubing sized roll grooved copper tube and fittings and bolting directly to ANSI Class 125 or Class 150 flanged components, manufactured by Victaulic Style 641.

2. Unless otherwise shown on the Drawings, all interior domestic water piping four inches (4") and smaller shall be fabricated of Type K, hard drawn, copper pipe made of deoxidized copper (99.9% pure). See Section 22 20 00. No pipe smaller than three-fourths inches (3/4") shall be used in this project except at local connections or as detailed for laboratory areas.

C. Fittings: See Section 22 20 00.

D. Headers:

1. Suitable headers of the nature detailed on the accompanying Drawings shall be provided for the distribution of the cold water systems. These headers shall be fabricated by a fusion welding process by the use of extra strong black steel pipe and fittings of the same character. All flanges used in the case of such headers shall be dimensioned, faced, drilled and spot faced to conform to the Class 150 American Standard for Steel Pipe Flanges and Flanged Fittings (B16e-1939). The header outlets shall be effected by welding to the header full length welding couplings of the proper size. These header outlets shall be carefully aligned to be "square" and parallel.

2. Upon being completed, these headers shall be subjected to a hydrostatic test of 300 pounds per square inch gauge. All defects noted upon inspecting the headers thus tested shall be repaired by chipping, machining and burning out defects, and re-welding. After repairs have been made, the headers shall be retested as described above.

3. After the headers have been tested and found to be tight, they shall be galvanized by a "double-dip" process. The manufacturer shall be required to provide certificates assuring the fact that the headers were so "double-dipped". Both exterior and interior surfaces shall receive a heavy zinc coating by a hot dipping process. Galvanized steel nipples shall be used to extend the various header outlets to the valves placed in each outgoing water line near the header. These nipples shall be of such a length that the valves in the outgoing water lines are neatly lined up in a horizontal plane. At a point just beyond these valves, a three-fourths inch (3/4") valved drain line shall be installed in each outgoing branch leaving the header. The purpose of such valve branches shall be to drain the system into which the flow of water is controlled by the valves previously mentioned. These three-fourths inch (3/4") drain line valves from the various branches leaving the headers shall be likewise lined up in a straight horizontal line. These three-fourths inch (3/4") drain lines shall terminate in a common "drain line". That one inch (1") drain line shall be the header drain line. Headers fabricated from copper pipe and roll grooved fittings may be substituted only with the written approval of the Owner.

E. Control Valves:

1. Control valves shall be installed where indicated on Drawings and/or wherever necessary for controlling the several sections of the domestic water system. Valves shall be provided on all inlet (and outlet where applicable) connections to all kinds of apparatuses, all risers and all groups of fixtures. Groups of fixtures shall be arranged to have their group valves in one location. Access shall be provided to all concealed valves by means of an access door. Coordinate the location of valves with the architectural features of the building in order that the access doors will be located symmetrically with other features.

2. The hot and/or cold water supply lines to each and every fixture hereinafter specified shall be equipped with stop valves which shall be chromium plated where exposed chrome plated pipe is used.

F. Cross Connections:

1. Care shall be exercised in fabricating plumbing lines to avoid all cross connections and to construct the piping systems in a manner which eliminates the possibility of water contamination.

2. The piping systems have been designed in every case to avoid the possibility of reverse flow or back siphoning. Care shall be exercised in constructing plumbing lines to make certain that not only the letter, but the spirit, of these safety precautions is carried out to the fullest possible extent.

G. Requirements of Interior Water Piping Systems:

1. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.

2. All exposed chrome plated, polished or enameled connections from fixtures shall be put up with special care, showing no tool marks or threads at fittings, and supported by neat racks or hangers with round head screws of same material and finish.

3. The fabrication of copper pipe and fittings shall in every detail conform to the recommendations and instructions of the fitting manufacturer. The tools used shall be the tools adapted to that specific purpose.

4. Refer to other parts of this Section and Section 22 00 00 and 22 20 00 for other information concerning installation of piping.

H. Testing and Sterilization:

1. All water piping systems shall be properly tested to assure their being absolutely tight. In the case of pipes which are to be insulated, these tests shall be completed and the piping system proven to be absolutely tight before any insulation is applied. Wherever pipes are placed so that they will ultimately be concealed, these tests shall be conducted and the absolute tightness of each piping system shall be demonstrated before the system is concealed.

2. The procedure of these tests shall consist of subjecting a piping system to a hydrostatic pressure per Section 22 00 00. During the test period, all pipe, fittings and accessories in the particular piping system which is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped by means designated by the Owner's duly authorized representative and the hydrostatic test shall again be applied. This procedure shall be repeated until, for an entire twenty-four hour period, no leaks can be found while the system being tested is subjected to the pressure mentioned above.

3. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five (5) days. During that period, it shall be kept under the most careful observation. The piping systems must demonstrate the propriety of their installation by remaining absolutely tight during this period. Even though the completion of these tests is satisfactory, there is a continuing responsibility for the ultimate, proper, and satisfactory operation of such piping systems and their accessories.

4. The sterilization process shall be conducted as required by the Health Department of the City of Edinburg , and the specifications above, and upon completion of the process, the Health Department shall test and certify the cleanliness of the water piping system. The Mechanical Subcontractor shall pay all costs and charges incidental to this test and certification.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations under provisions of Section 22 00 00.

B. Verify that 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.

3.3 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Establish elevations of buried piping outside the building to ensure a minimum of cover. Refer to Section 22 00 00.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Provide support for utility meters in accordance with requirements of utility companies.

L. Excavate in accordance with Section 22 00 00 for work of this Section.

M. Excavate in accordance with Section 22 00 00 for work of this Section.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

P. Provide one plug valve wrench for every ten plug valves sized 2 inches and smaller, minimum of one. Provide each plug valve sized 2-1/2 inches and larger with a wrench with set screw.

Q. Provide one plug valve wrench for every ten plug valves sized 2 inches and smaller, minimum of one. Provide each plug valve sized 2-1/2 inches and larger with a wrench with set screw.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

C. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install globe or plug valves for throttling, bypass, or manual flow control services.

E. Provide spring loaded check valves on discharge of water pumps.

F. Provide flow controls in water recirculating systems where indicated.

3.5 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean. After completion of the testing, the entire cold and hot water piping systems, with attached equipment, shall be thoroughly sterilized.

B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.7 EQUIPMENT CONNECTIONS

A. Under this section, water lines shall be run to and connected to the pumps, quick fills, and other items of equipment as indicated. Provide suitable shutoff valves, check valves, and, if required by the drawings, bypass valves at each and every such point of connection.

3.8 CONNECTIONS FOR GENERAL CONTRACTOR FURNISHED EQUIPMENT

A. Route lines as indicated on the Drawings to serve various items of equipment specified elsewhere. Rough-in accordance with detailed drawings furnished by the equipment supplier, and make final connections to the equipment when it is installed. Rough-in shall terminate where noted on Drawings. All pressure lines shall be provided with shutoff valves or cocks. Drain lines shall be provided where required. It shall be assumed that the equipment supplier will provide and install valves and pipe specialties, etc. only as specified herein or called for on the Drawings.

END OF SECTION 22 13 16

SECTION 22 13 17 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Basic Plumbing Requirements

B. Section 22 05 29 – Plumbing Supports and Sleeves

C. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Roof drains

B. Floor Drains and Floor Sinks

C. Cleanouts

D. Backflow preventers

E. Water hammer arrestors

F. Interceptors

1.3 RELATED SECTIONS

A. Section 01 11 00 - Summary of Work

B. Section 33 05 13 - Manholes and Structures

C. Section 22 13 16 - Plumbing Piping

D. Section 22 40 00 - Plumbing Fixtures

E. Section 22 11 23 - Plumbing Equipment

1.4 REFERENCES

A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers

B. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent

C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle

D. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types

E. ANSI A112.21.1 - Floor Drains

F. ANSI A112.21.2 - Roof Drains

G. ANSI A112.26.1 - Water Hammer Arrestors

H. ASTM C478 - Precast Reinforced Concrete Manhole Sections

I. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types

J. PDI WH-201 Water Hammer Arresters

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

C. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

D. Manufacturer's Installation Instructions: Indicate assembly and support requirements.

E. Manufacturer's Certificate: Certify that oil interceptors meet or exceed specified requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 00.

B. Record actual locations of equipment, cleanouts, backflow preventers, etc.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 00.

B. Operation Data: Indicate frequency of treatment required for interceptors.

C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 00.

B. Accept specialties on site in original factory packaging. Inspect for damage.

1.9 EXTRA MATERIALS

A. Furnish under provisions of Section 22 00 00.

B. Provide two loose keys for each type of manhole cover and valve box.

PART 2 - PRODUCTS

2.1 ROOF AND AREA DRAINS:

A. All roof and area drains will be furnished and installed by the Mechanical Contractor with all accessories required for the particular construction in which they are to be mounted. Area drains shall be as manufactured by Wade, Josam, Jay R, Smith, Mi-Fab or Zurn.

B. Unless otherwise specified on plans.

C. Roof Drain Type A (RD "A"): Wade No. 3000-5-39-52-53, galvanized cast iron body with flashing clamp, sump receiver, underdeck clam, mushroom cast iron dome strainer and large sump.

D. Unless otherwise specified on plans.

E. Overflow Drain Type (OD “A”): Wade No. 3000-5-39-52-53-SD, cast iron body with flashing clamp, sump receiver, underdeck clamp, mushroom galvanized cast iron dome strainer, large sump with PVC standpipe or adjustable height internal water dam. Cut and/or adjust height of standpipe or internal water dam to code required height (2”).

F. Downspout Nozzle: Wade No. 3940-NH-1-166, nickel bronze downspout nozzle with no-hub inlet, stainless steel bird screen, polished finish, outlet tongue, and securing ring.

2.2 FLOOR DRAINS:

A. Floor drains (F.D.) shall be sized to conform to the information indicated on the Drawings or contained elsewhere in these Specifications. Extreme care shall be used to set the elevation of the drain to meet the low point elevation of the finished floor. Each floor drain shall be provided with a P-trap unless noted otherwise. Note that a deep seal type trap may be required under other Sections of these Specifications.

B. All floor drains will be furnished and installed with all accessories required for the particular construction in which they are to be mounted; and shall be as manufactured by Wade, Jay R. Smith, Mi-Fab or Zurn.

C. Unless otherwise specified on plans.

D. Floor Drain (In Finished Areas) Type A (FD "A"): Wade No. 1100-AX, cast iron floor drain with integral reversible clamp device, caulk device, caulk outlet and 6” round adjustable nickel brass strainer, and ½” plugged trap primer tap.

E. Unless otherwise specified on plans.

F. Floor Sink Type B (FS-“B”): Wade No. 9130-6-16-26-27, 12” square floor sink with 6” sump, acid resistant epoxy coated interior, nickel bronze frame and ¾ nickel bronze grate, aluminum sediment bucket and clamping device and ½” plugged trap primer tap.

2.3 CLEANOUTS:

A. At each change in direction, at the end of each continuous waste line, at the foot of each riser in the building and at 50' intervals in long horizontal runs, of lines of four inch (4") size and smaller, and not more than 95' intervals for larger lines, cleanouts shall be placed in soil and waste lines. The size of the cleanouts shall be identical with the size of the soil or waste line in which they are placed for four inch (4") and smaller lines. The size of cleanouts in lines larger than four inches (4") shall be six inches (6") in all cases. All cleanouts shall be placed to be easily accessible for servicing. Where they occur in pipe chases, they shall be placed above the floor in such a location so they will be easily accessible through access doors, or they shall be brought through the walls and be provided with covers. All horizontal soil and waste lines shall have a cleanout placed in the end of the line by the use of a wye and a 1/8 bend, or by a combination tee-wye and made easily accessible by extending the cleanout through the wall and be covered as described above. The screw plug of all cleanouts shall be of cast brass.

B. The bodies of floor cleanouts shall be tapped for iron pipe threads. The brass tap screws shall have flange caps with raised nuts. Wherever such cleanouts occur in finished floor slabs or terminate in finished walls, they shall be provided with scoriated nickel bronze cleanout covers of such a size as to make the plugs over which they are installed readily accessible. These cleanouts shall be cast iron floor cleanout with cut-off ferrule, tapered brass plug with eight inch (8") round screwed brass access cover with three-eighths inches (3/8") diameter Allen Head Screw.

C. All cleanouts shall be manufactures by Wade, Zurn, J.R. Smith, Mi-Fab or Josam. The specified manufactures and model number is the basis of design and the other listed manufacturers may be used, but must be equivalent to specification.

D. Finished Floors and Concrete Floors, Round Top. Primer coated cast iron floor cleanout with SV hub outlet, taper thread bronze plug, threaded adjustable housing and ferrule, membrane flange, secured/vandal proof, round-heavy duty satin finished nickel bronze scoriated top that adjusts to finished floor after concrete has set. For cleanouts located under carpet floors provide an integral carpet marker to indicate location after floor carpeting is installed. Reference Architectural drawings for areas with carpet floors. Wade No. 6000-Z-1-75-Threaded/Machined for Clamp Device (-CM, where applicable, or approved equal as manufactured by Zurn, J.R. Smith, Mi-Fab or Josam. Set top of floor cleanouts such that top is flush with finished floor.

E. Outside Areas, Round Top. Primer coated cast iron, extra heavy traffic duty floor cleanout with taper thread bronze plug, threaded adjustable housing with flanged ferrule, secured/vandal proof, round, extra heavy duty, gasketed satin finished nickel bronze scoriated top that adjusts to finished grade in field after installation. Cast cleanouts flush in a 16" by 16" by 6" thick concrete pad. Concrete pad and cleanout shall be installed such that the top of pad and cleanout top are both set with top flush with finished grade. Wade No. 6000-Z-1-755 or approved equal as manufactured by Zurn, J.R. Smith, Mi-Fab or Josam. Set top of exterior floor cleanouts such that top is flush with finished grade.

F. Finished Walls. Primer coated cast iron cleanout tee with countersunk head, taper treaded bronze plug, No-Hub connections and 6-inch diameter-smooth-stainless steel secured access cover with secured/vandal proof screw. Manufactured by, Wade W-8460, or approved equal as manufactured by Zurn, J.R. Smith, Mi-Fab or Josam.

G. Unfinished Areas. Primer coated cast iron cleanout tee with countersunk head, taper thread bronze plug and No-Hub connections. Wade W-8560-MODIFIED for No-Hub connections-D. approved equal as manufactured by Zurn, J.R. Smith, Mi-Fab or Josam.

2.4 **STRAINERS**:

A. Strainers 2" and smaller, Class 125 ASTM B62 bronze body, screwed ends, No. 20mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap), rated for 200 psi working pressure, manufactured by Nibco No. T-221-B, or approved equal. Strainers 2 1/2" and larger, ASTM A126-B cast iron body, class 125, rated for 200 psi working pressure, isolating type flanged ends where installed in copper lines, No. 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap). Special Note: All strainers 6" and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing. Cast iron strainers shall have FDA approved internal lining for domestic water service, manufactured by Nibco No. F-721-A, or manufactured with equivalent model.

2.5 BACKFLOW PREVENTERS AND VACUUM BREAKERS:

A. Atmospheric Vacuum Breakers: Full line size, manufactured of brass or bronze with full size orifice, dry guide out of the liquid pressure area and disc float closing vent with minimum flow. Manufactured by Watts Regulator, No. 188A Series, or equivalent model by Wilkins or Conbraco (Apollo).

B. Reduced Pressure Backflow Preventer (RPZ): Size as indicated on Drawings, bronze construction, rated for 175 psi, and shall include strainer, gate or ball valves based on size, pressure differential relief valve, check valves, test cocks, and relief vent and funnel drain. Unit shall meet the requirements of ASSE 1013, and AWWA, University of Southern California tested and approved. Manufactured by Watts Regulator No. 909, or by Wilkins or Conbraco (Apollo).

C. Double Check Valve Assembly: For sizes up to 2 inches provide lead free cast copper silicon alloy body with threaded end connections, with replaceable seats and seat discs, top mounted ball valve test cocks. Unit shall meet the requirements of ASSE 1015, AWWA c510, University of Southern California testes and approved, manufactured by Watts model (FOD) or equivalent model by Wilkens or Combraco (Apollo). For sizes over 2 inches provide lead free unit with epoxy coated cast iron body with stainless steel seats, flanged and connections, complete with gate valves on inset and discharge. Unit shall meet the requirements of ASSE 1015, AWWA C510-92, CSA B 64.5 and University of Southern California tested and approved, manufactured by Watts Model LF 709 or by Wilkins or Conbraco (Apollo).

2.6 VALVE BOXES:

A. For each underground valve installed by the Contractor, the Contractor shall provide and install a two-piece, screw adjustable type valve box. These valve boxes shall be designed for heavy roadway service and they shall have a deep socket type of cover which prevents their being accidentally knocked out of position.

B. The word "WATER" shall appear on each cover. The installation of these members shall be such that by the use of the adjustable screw type bodies the tops are just flush with the finished grade. These valve boxes shall be Tyler Pipe Industries #6850, or approved equal.

2.7 TRAP PRIMERS:

A. Electronic Type: Electronic trap priming manifo9ld, surface mounted, complete with resettable timer, factory assembled, pre-piped bronze body, 1/2” inlet and water connection, solenoid valve, Type ”L” copper manifold with brass ½” compression fittings with single point 120 volt electrical connection with manual override switch, 16 gauge steel enclosure with door and integral atmospheric vacuum breaker, with mounting anchors, manufactured by PPP Inc., “Prime Time” or approved equal.

2.8 EXPANSION TANKS:

A. ASME coded pre-charged hydro pneumatic steel expansion tank, constructed with a maximum working pressure of 150 psig. Internal wetted parts shall be compliant with FDA regulations and approvals. Internal butyl diaphragm isolating water from air, 2 gallon tank volume, 8” diameter, 8” height, 3/4” NPT pipe connection, manufactured by Amtrol “Therm-X-Trol” Model No. ST-5C or by Watts or Taco.

2.9 WATER HAMMER ARRESTORS:

A. Provide hydraulic shock water hammer arrestors in domestic cold water and domestic hot water lines to each individual plumbing fixture or battery of fixtures, and at each automatic solenoid operated or quick closing valve serving equipment. Shock water hammer arrestors shall be of seamless type “K” copper body construction or type 304 stainless steel body with stainless steel bellows, nitrogen and helium gas pre-charged. Shock arrestors shall be certified to ASSE 1010-2004 Standard and listed with IAPMO, completely sealed and operating free of casing. Size all units according to water hammer arrestors standard PDI-WH-201. The shock arrestors shall have a life time warranty and shall be designed to provide continuous protection without maintenance allowing the shock arrestor to be installed without an access panel. Manufactured by Sioux Chief “Hydra-Rester”, Wade or Jay. R. Smith.

2.10

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

B. Verify location of equipment and housekeeping pads prior to installation of floor drains.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Pipe relief from back flow preventer to nearest drain.

E. Install water hammer arrestors complete with accessible isolation valve and wall access panel where serving banks of plumbing fixtures. For single plumbing fixtures locate the water hammer arrestors above the ceiling with ceiling access panel. Where located above a lay-in ceiling, the ceiling access panel is not required.

F. All backflow preventers shall be installed within the building.

G. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then all of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and re-installed using all new materials.

END OF SECTION 22 13 16.A

SECTION 22 20 00–PLUMBING PIPING, VALVES AND FITTINGS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 2200 00 – Plumbing Basic Requirements

B. Section 22 05 29 – Plumbing Supports and Sleeves

C. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES

A. Pipe and Pipe Fittings

B. Valves

1.3 RELATED SECTIONS

A. Section 02222 - Excavating

B. Section 31 23 23.13 - Backfilling

C. Section 31 23 16.13 - Trenching

D. Section 33 13 00 - Disinfection of Water Distribution System

E. Section 08 31 13 - Access Doors and Frames

F. Section 09 91 00- Painting

G. Section 22 05 48 –Plumbing Vibration Isolation

H. Section 23 07 19 - Plumbing Insulation

I. Section 22 13 16.A - Plumbing Specialties

J. Section 22 40 00 - Plumbing Fixtures

K. Section 22 11 23 - Plumbing Equipment

1.4 REFERENCES

A. AGA - American Gas Association

B. ANSI B31.1 - Power Piping

C. ANSI B31.9 - Building Service Piping

D. ASME - Boiler and Pressure Vessel Code

E. ASME Sec. 9 - Welding and Brazing Qualifications

F. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800

G. ASME B16.3 - Malleable Iron Threaded Fittings

H. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250

I. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings

J. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings

K. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV

L. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes

M. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV

N. ASME B16.32 - Cast Copper Alloy Solder-Joint Fittings for Solvent Drainage Systems

O. ASTM A47 - Ferric Malleable Iron Castings

P. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless

Q. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

R. ASTM B32 - Solder Metal

S. ASTM B42 - Seamless Copper Pipe

T. ASTM B43 - Seamless Red Brass Pipe

U. ASTM B75 - Seamless Copper Tube

V. ASTM B88 - Seamless Copper Water Tube

W. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube

X. ASTM B302 -Threadless Copper Pipe (TP)

Y. ASTM B306 - Copper Drainage Tube (DWV)

Z. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings

AA. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

BB. ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings

CC. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

DD. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

EE. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

FF. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping

GG. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter - Controlled Polyethylene Pipe

HH. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

II. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

JJ. ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems

KK. ASTM D2855 - Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings

LL. ASTM D3033 - Type PSP Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings

MM. ASTM D3034 - Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings

NN. ASTM D3309 - Polybutylene (PB) Plastic Hot Water Distribution System

OO. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe

PP. ASTM F493 - Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings

QQ. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Pipe

RR. AWS A5.8 - Brazing Filler Metal. BA. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

SS. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids

TT. AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings

UU. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

VV. AWWA C651 - Disinfecting Water Mains

WW. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hub less Cast Iron Sanitary Systems

XX. CISPI 310 - Joints for Hub less Cast Iron Sanitary Systems

YY. CAN-3 B281 - Aluminum Drain, Waste, and Vent Pipe and Components

ZZ. NCPWB - Procedure Specifications for Pipe Welding

AAA. NFPA 54 - National Fuel Gas Code

BBB. NFPA 58 - Storage and Handling of Liquefied Petroleum Gases

CCC. TDH - Texas Department of Health, Water System Regulations

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 00.

B. Record actual locations of valves, etc. and prepare valve charts.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welder's Certification: In accordance with ASME Sec. 9**.** Submit welder's certifications prior to any shop or field fabrication. Welder's certifications shall be current within six months of submission.

D. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this sectionwith minimum three years' documented experience.

B. Installer: Company specializing in performing the work of this sectionwith minimum of three years' documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 00.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sectionsof the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.12 EXTRA MATERIALS

A. Furnish under provisions of Section 22 00 00.

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 STEEL PIPING:

A. Scope: This sectionapplies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, steam condensate, and fire protection systems.

B. Pipe: Unless otherwise indicated, steel piping shall be Schedule 40, shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM Designation A135, A106, and A53, latest revisions.

C. Fittings:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weld Bend, Tube Turn, Hackney, or Ladish Company. Attach to only pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed, or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting is to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Anvil, Crane Company or Walworth Company manufacture (300 lb. for unions).

D. Fabrication:

1. Welded piping and fittings in chiller and boiler plants shall be fabricated in accordance with ASME/ANSI the latest editions of Standards B31.1 and B31.3 for Steam and Condensate systems, from the Code for Pressure Piping. Standard B31.9 –Building Services Piping may be used within buildings. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersectionof lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

E. Weld Testing:

1. All welds are subject to inspection, visual, X-ray, or Ultrasound for compliance with specifications. The owner will, at the owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and re-testing of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1, B31.9,and B31.3 due to the discovery of poor, unacceptable, or rejected welds.

2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section6 of the Code, current edition.

2.2 CAST IRON PIPING:

A. Piping & Fittings:

1. Service weight cast iron soil pipe conforming to ASTM Specification A-74 and CISPI Standard 301, hub and spigot for pipe ten inch (10") and larger and hub less for eight inch (8") and smaller. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer's mark or name cast on it.

2. All joints in hub and spigot cast iron pipe shall be made water and gas tight with Tyseal neoprene gaskets. Lead and Oakum may be used only under special conditions, with prior written permission from the Resident Construction Manager. Joints in hub less cast iron soil pipe and fittings shall be made by the use of a neoprene sleeve and 24-gauge, Type 304 Stainless Steel shield made tight with a torque wrench and torqued to a minimum of 100 inch-pounds. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material. Each clamp shall bear the FM and UPC stamp, shall be approved to Class I of Factory Mutual Standard #1680, and shall be Clamp-All, Anaco "Husky" SD 2000 or Mission "HW". All elbows and tees shall be braced against thrust loads which might result in joint separation due to static pressure or dynamic forces caused by sudden, heavy impulse loading (water hammer) conditions. Hub less piping systems shall not be used in a directly buried, underground application.

2.3 DUCTILE IRON PIPING

A. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 ductile iron pipe arranged with bell and spigot mechanical joints and shall conform in every detail to Federal Specifications WW-P-421, E-4, Type II for cast iron pipecentrifugally castin sand lined molds. This pipe shall be provided in laying lengths of sixteen feet (16'). Each length of pipe shall be plainly marked in such a fashion as to indicate the name or trademark of the manufacturer and the year in which the pipe was cast. Exterior surfaces shall be completely coated with coal tar pitch varnish to which sufficient oil has been added to effect a smooth coating, tough and tenacious when cold, not "tacky" and not brittle.

B. Fittings:

1. All fittings used for underground water piping mains shall be Class D bell and spigot mechanical joint fittings made in strict conformity with the Specifications of the American Water Works Association A.W.W.A.-C100-08. All dimensions and weights of such fittings shall conform to the dimensions and weights shown in tables included in the latest edition HANDBOOK OF CAST IRON PIPE published by Cast Iron Pipe Research Association. All fittings shall be coated outside with the same coal tar pitch varnish used on cast iron pipe.

2. All mechanical joints shall be for cast iron pressure pipe made by pit cast or by centrifugal methods and cast iron pressure fittings. Mechanical joints shall be of the stuffing box type and shall consist of a bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting; a pipe or fitting spigot; a sealing gasket; a separate cast iron follower gland having cored or drilled bolt holes. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe line.

3. Bolts shall be high strength, heat treated cast iron tee-head bolts with hexagon nuts.

4. Gaskets shall be made of a vulcanized crude rubber compound and, unless otherwise specified, the rubber shall be first grade plantation rubber. The joint, gaskets, bolts, and nuts shall meet the latest requirements of ANSI 21.11 for Mechanical Joints for Cast Pressure Pipe and Fittings.

5. All underground cast iron or ductile iron pipe shall be encased in black 8-mil thick, polyethylene plastic sheet, per ANSI/AWWA, C105/A21.5-82, Method C.

6. Tie rods and retaining bolts shall be all stainless steel construction.

C. Valves: All valves used in underground water piping systems shall be A.W.W.A., iron body, mechanical joint, double hump, double disc, parallel seats, brass trimmed non-rising stem gate valves.

2.4 GALVANIZED STEEL PIPE

A. Pipe: Schedule 40 and shall conform in every detail to ASTM Standard Specifications for black and hot dippedzinc-coatedgalvanized weldedand seamlesssteel pipe ASTM Designation A-135, latest revision. This threaded pipe shall be supplied with thread protectors on each end. All steel water pipe shall be hot-dipped galvanized pipe zinc coated both inside and outside.

B. Fittings: All fittings for six inch (6") and larger water lines shall be 125 lb., cast iron, flanged pattern fittings. These fittings shall be hot-dipped galvanized, after all machining operations have been completed. These fittings shall be of Crane Company, or approved equal, manufacture and their flanges shall be dimensioned, faced drilled and spot faced to conform to the Class 150 American Standard for Steel Pipe Flanges and Flanged Fittings.

2.5 COPPER PIPE

A. Copper Pipe: Piping four inches (4") and smaller shall be fabricated of Type K, hard drawn, copper pipe made of deoxidized copper (99.9% pure). This Type K copper pipe shall conform in every detail to ASTM Standard Specifications for copper water tube, Serial Designation B-88-66, and it shall be provided in 20-foot straight lengths. Copper pipe 4" and smaller may only be joined using non-lead-bearing solder, such as 95-5 silver or antimony solder (95 percent tin, and 5 percent silver or antimony). Copper pipe 5"and larger may be joined using roll grooved fittings.

B. Fittings: All fittings for four inch (4") and smaller water lines shall be Streamline Solder Fittings manufactured by Streamline Pipe and Fittings Division, Mueller Brass Company, Nibco Inc., or approved equal. These wrought copper fittings shall be rigid and strong with openings machined to accurate capillary fit for the pipe.

C. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

2.6 PVC PIPING

A. Only where allowed in another Division 22 specification.Type 1 Schedule 40 PVC pipe conforming to ASTM D-1784. For pressurized systems, pipe shall be marked with manufacturer's name or trademark, material designation code, nominal pipe size, pipe schedule size with pressure rating in PSI for water at 73 degrees F, the ASTM designation number D-1785 and the NSF seal for potable water. For gravity drainage systems pipe shall be marked with manufacturer's name or trademark, the ASTM designation code number D-2665, the nominal pipe size, the material abbreviation PVC, and the product abbreviation DWV spaced along the entire pipe length at not more than (2) foot intervals. For gravity drainage systems the fittings shall be DWV pattern with solvent cement joints conforming to ASTM D2665. For pressurized systems schedule 40 fittings shall conform to ASTM D-2466 with socket solvent cement joints.

2.7 PVDF PIPING

A. Refer to specification section 22 66 00 or section 22 67 13, where allowed.

2.8 VALVES:

A. All valves in the domestic water system shall be Lead Free. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. All valves must be of threaded or flanged type. **No solder connected or grooved fitting valves shall be used on this project.** All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc. The following manufacturers are acceptable: Apollo, Kitz, Nibco, Stockham, Milwaukee, Rockwell, DeZurik and Mueller.

B. All valves used in plumbing systems shall be Class 150 SWP. Class 300 valves shall be constructed of all ASTM B-61 composition. All gate, globe and angle valves shall be union bonnet design. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. Alloys used in all bronze ball, gate, globe, check, or angle valves shall contain no more than 15% zinc. No yellow brass valves will be allowed.

C. All iron body valves shall have the pressure containing parts constructed of ASTM designated of 126 class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing.

D. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16-34-1977. Stems shall meet ASTM designation A-186-F6 chromium stainless steel. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6 chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be A-216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

E. All forged steel body valves shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

F. All valves shall be repackable, under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

G. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.

H. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass valve assembly.

I. Balancing and/or Shutoff Valves for Domestic Hot Water Systems: Two inches and smaller, three piece full port bronze body ball valve, stainless steel ball and stem. Teflon seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle, with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use in insulated lines. Cold water service valves shall be as above, except two piece construction. All valves 2 1/2" and larger shall be tapped full lug butterfly valves with aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12" (150 psi for larger valves) when used for end of

line service without requiring the installation of a blind flange on the downstream side. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 8" and larger and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron handwheel or crank. Valves 2 1/2" through 6" shall have lever handles which can be set in interim positions between full open and full closed. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

J. Check Valves for Water Systems: Bronze body, 2" and smaller, bronze body regrinding disc and seat with screw-in cap. Iron body, 2 1/2" and larger, bronze disc and seat or non-slam wafer type with stainless pins and springs, and bronze plate. Forged steel lift check valves, 2" and smaller shall be bolted cap and body, screwed end connections and conform to ANSI B16.34 and pressure temperature rating.

K. Gate valves 2 1/2” and larger shall have approved rating of 175 psi WWP or greater, iron body with resilient rubber encapsulated wedge, epoxy-coated interior and pre-grooved stem for supervisory switch.

L. Standards of Quality for Valves:

Standard of Quality for Valves:

Size	Type	Service	Class	Milwaukee	Nibco	Stockham, or as
*2" & smaller	Ball Valve for shut-off	Domestic Cold Water Systems	150	--	T-585-80-LF	Apollo77FLF-100
*2” & Smaller	Ball Valve for shut-off	Domestic Hot Water Systems & Recirculating Dom. Hot Water	150	--	T-595-Y-66-LF	Apollo 77-140
*Requires extended stems in insulated lines with adjustable memory stop.						
2-1/2" & larger	Globe, Angle & Balancing	Plumbing	125	F-2981	F-718-B	G-514-T
2-1/2" & larger	Butterfly	Domestic Hot & Cold Water Systems Shutoff	150	NE-C,NF	LD2000	DeZurik 632, L, D, RS66,6

2.9 UNIONS:

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass

flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to Epco.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a dielectric coupling shall be used at the transition.

2.10 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All-thread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. Flange Gaskets

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets for all other applications: Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16” thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

3. Spares - Contractor shall provide ten spares for every flange size and rating.

D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

Nominal Bolt Dia. (Inch)	Torque (Ft-Lbs)
.25	6
.3125	12
.375	18
.4375	30
.5	45
.5625	68
.625	90
.75	150
.875	240
1.0	368
1.125	533
1.25	750
1.375	1020
1.5	1200

3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

6. Inspection - Owner shall verify hot torqueing of all medium and high pressure steam flange bolts.

PART 3 - EXECUTION

3.1 REFER TO OTHER SECTIONSFOR SERVICE SPECIFIC REQUIREMENTS.

3.2 EXAMINATION

A. Verify excavations under provisions of Section 22 00 00.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.3 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.

3.4 INSTALLATION

A. Install unions downstream of valves and at equipment or apparatus connections. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Establish elevations of buried piping outside the building to ensure a minimum of cover. Refer to Section 22 00 00.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Division 09.

L. Excavate in accordance with Section 22 00 00 for work of this Section.

M. Backfill in accordance with Section 22 00 00 for work of this Section.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

3.5 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

END OF SECTION 22 20 00

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 22 00 00 – Plumbing

B. Section 22 05 29 – Plumbing Supports & Sleeves

C. Section 22 05 53 – Plumbing Identification

1.2 SECTION INCLUDES:

A. Lavatories

B. Sinks

C. Service Sinks

D. Water Closets

E. Urinals

F. Faucets

G. Electric Water Coolers / Drinking Fountains

H. Hose Bibbs

I. Thermostatic Mixing Valves

J. Vacuum Breakers

K. Laboratory Fittings

L. Eyewash Fountains

M.

1.3 RELATED SECTIONS

A. Section 06410 - Custom Casework: Preparation of Counters for Sinks

B. Section 06410 - Custom Casework: Lavatory Tops

C. Section 07 90 00 - Joint Sealers: Seal Fixtures to Walls and Floors

D. Section 22 05 29 - Plumbing Supports and Sleeves

E. Section 22 13 16 - Plumbing Piping

F. Section 22 13 16.A - Plumbing Specialties

G. Section 22 11 23 - Plumbing Equipment

1.4 ALLOWANCES

A. Cash Allowance: Include under provisions of Section 22 00 00.

B. Allowance includes purchase and delivery of owner-selected fixtures. Installation is included in this section and is part of the Contract Sum/Price.

1.5 REFERENCES

A. ANSI/ASME A112.6.1 - Supports for Off the Floor Plumbing Fixtures for Public Use.

B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.

D. ANSI/ASME A112.19.2 - Vitreous China Plumbing Fixtures.

E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. ANSI/ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

G. ANSI/ASME A112.19.5 - Trim for Water Closet Bowls, Tanks, and Urinals (Dimensional Standards).

H. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

I. ANSI/ARI 1010 - Drinking Fountains and Self Contained, Mechanically Refrigerated Drinking Water Coolers.

J. NSF/ANSI 61: Drinking Water System Components – Health Effects.

1.6 SUBMITTALS

A. Submit under provisions of Section 22 00 00.

B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough in dimensions, utility sizes, trim, and finishes.

C. Manufacturer's Installation Instructions.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 00.

B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.8 MOCKUP

A. Provide mockup of typical bathroom group under provisions of Section 22 00 00.

B. Mockup may [not] remain as part of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 00.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.10 FIELD MEASUREMENTS

A. Verify that field measurements are either as indicated on shop drawings or as instructed by the manufacturer, and designate in the submittal both that it has been verified, and which measurements are the basis for construction.

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

1.11 WARRANTY

A. Provide five-year warranty under provisions of Section 22 00 00.

B. Warranty: Include coverage of electric water cooler compressor.

1.12 EXTRA MATERIALS

A. Furnish under provisions of Section 22 00 00.

B. Provide two each of each type of faucet service kits, flush valve service kits.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall provide plumbing fixtures where indicated on the Drawings. These plumbing fixtures shall be standard products as manufactured by Kohler, Crane, American Standard. The fixtures shall be free from mars or chips and shall be new, first quality and shall be furnished with sufficient supports in order to adequately hang each and every unit. The space between fixtures and masonry walls shall be grouted with White General Electric Silicone flexible grout. The space between fixtures and sheetrock or wood panel walls shall not be grouted but the fixture shall fit flat against the wall surface with no more than 1/16" gap.

B. All faucets, fittings, supply stops and similar devices shall be of one manufacturer unless otherwise specified. All water faucets and valve bodies shall be cast brass with a minimum copper content of 85%. They shall contain standardized interchangeable operating units constructed of a removable and replaceable unit containing all parts subject to wear. All water faucets shall contain an adjustable internal volume control unit. All exposed parts shall be chromium plated.

C. All fixtures shall meet the requirements of ADA, ANSI A117.1, ANSI Z124.2 and the State of Texas Accessibility Standards (TAS).

D. All faucets shall comply with NSF 61..

2.2 FITTINGS AND PIPES:

A. Fittings and piping shall be brass and, wherever exposed, shall be polished chrome-plated. Provide tight fitting wall or floor escutcheons of chrome-plated brass wherever pipes pass through floors, walls or ceilings.

B. Furnish and install all required water, waste, soil and vent connections to all plumbing fixtures, together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.

C. Supplies for all lavatories, sinks, and drinking fountains shall be loose key angle stops with 1/2" I.P.S. female inlets and shall include wall flanges, and 1/2" O.D. flexible risers with bull-nose or flared end outlets. All components to be chrome plated. In all cases, all piping, tubing, fittings, and faucets shall be installed using a mechanical non-slip connection, such as bull-nose, flared, flanged, ferrule, or threaded fittings. Fittings requiring a friction fit using slip-on or gasketed connections are not acceptable.

2.3 LAVATORIES - GENERAL TOILET ROOMS - LAVATORY TYPE "L-A":

A. American Standard "AQUALYN" No. 0475.020ADA compliant, white vitreous china, self-rimming, counter top, oval lavatory. Lavatory fixture shall measure 20-inches wide by 17-inches deep, shall have faucet holes on 8-inch centers and shall be equipped with integral front-overflow ports. Alternative acceptable manufacturers: Equal products by Kohler or Crane.

B. Chicago Faucet 786-E2805-5ABCPADA compliant, 8-inch center spread, concealed fitting lavatory faucet with 5inch gooseneck spout, 4-inch wrist blade handles, 0.50 gpm vandal proof spray outlet. The force required to activate the faucet controls shall be no greater than 5 ftlb. Faucet shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Acceptable alternative manufacturers: Equal products by T&S Brass or Water Saver.

C. McGuire No. 155WC, ADA compliant, chrome plated offset lavatory strainer, with heavy cast brass grid drain strainer, heavy cast base elbow and 1-1/4 inch 17-gauge tubular brass offset tailpiece. Acceptable alternative manufacturers: Equal products by Chicago, or Zurn.

D. Chicago Faucet 1006-ABCP supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets 12" long, 1/2" O.D. flexible risers, wall flanges, and 1/2" O.D. flexible tube risers with bull-nose outlets. Acceptable alternative manufacturers: Equal products by McGuire or Zurn.

E. McGuire 8902, (or) 1-1/4" inlet and 1-1/2" outlet adjustable cast brass P-traps with cleanout plug, brass threaded nipple from trap to tapped sanitary tee behind wall, chrome-plated cover tubing to wall and chrome plated wall escutcheon. Acceptable alternative manufacturers Equal products by: Zurn or Kohler.

F. Insulate all exposed drain and supply piping with Plumberex Specialty Products "HANDY SHIELD," or equivalent model by Truebro, drain line and supply line safety covers.

2.4 LAVATORIES - GEN. HC - LAVATORY TYPE "L-C"

A. American Standard Lucerne" No. 0356.915 (Zurn). ADA compliant, rectangular, white vitreous china, wall-hung lavatory. Lavatory fixture shall measure 20-1/2 inches wide by 18-1/4 inches deep, shall have faucet holes on 8-inch centers and shall be equipped with integral rear-overflow ports. Fixture size, design and mounting height shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Acceptable alternative manufacturer: Equal products by Crane or Kohler.

B. Lavatory carrier shall consist of concealed arms with pipe uprights, welded base feet and support hardware, adjustable steel construction, manufactured by Wade 520 Series Acceptable alternative manufacturers: Equal products by Zurn, J.R. Smith or Josam.

C. Chicago Faucet 786-E2805-5ABCP ADA compliant, 8-inch center spread, concealed fitting lavatory faucet 5 inch gooseneck spout, 4-inch wrist blade handles,0.50 gpm vandal proof spray outlet. The force required to activate the faucet controls shall be no greater than 5. Faucet shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Acceptable alternative manufacturers: Equal products by T&S Brass Water Saver,.

D. McGuire No. 155WC, , ADA compliant, chrome plated offset lavatory strainer, with heavy cast brass grid drain strainer, heavy cast base elbow and 1-1/4 inch, 17-gauge tubular brass offset tailpiece. Acceptable alternative manufacturers: Equal products by Chicago or Zurn.

E. Chicago Faucet 1006-ABCP supplies, with loose key angle stops, lock shield caps, 1/2" I.P. female inlets 12" long, 1/2" O.D. flexible risers, wall flanges, and 1/2" O.D. flexible tube risers with bull-nose outlets. Acceptable alternative manufacturers: Equal products by McGuire or Zurn.

F. McGuire 8902, (or equal as manufactured by) 1-1/4" inlet and 1-1/2" outlet adjustable cast brass P-traps with cleanout plug, brass threaded nipple from trap to tapped sanitary tee behind wall; chrome-plated cover tubing to wall and chrome plated wall escutcheon. Acceptable alternative manufacturers: Equal products by Zurn or Kohler.

G. Insulate all exposed drain and supply piping with Plumberex Specialty Products "HANDY SHIELD" or equivalent model by Truebro drain line and supply line safety covers.

H. Insulate all exposed drain and supply piping with Plumberex Specialty Products "HANDY SHIELD," or equivalent model by Truebro drain line and supply line safety covers.

2.5 MOP SINKS - JAN. CLOSETS - MOP SINK TYPE "MS-A":

A. Stern-Williams "SERVICEPTOR" No. SB-702-BP2, 32-inch x 32-inch x 12-inch deep corner type terrazzo mop sink with continuous stainless steel cap on all four sides and tilting flange on two sides. Equip fixture complete with nickel bronze strainer and stainless steel splash catcher panels on two sides. Acceptable alternative manufacturers: Equal products by C.I.T., Fiat or Oberon.

B. Chicago Faucet 897-CRCF rough chrome plated service sink faucet with vacuum breaker spout, 3/4" hose thread on spout, adjustable wall brace, pail hook, integral stops in supply arms, and No. 245/LF integral flow control cartridges. Acceptable alternative manufacturers: Equal products by T&S Brass or Water Saver.

C. Stern-Williams No. T-35 36-inch long hose with 3/4-inch polished chrome coupling and stainless steel wall bracket with rubber grip. Acceptable alternative manufacturer: Equal products by C.I.T., Fiat or Oberon.

D. Stern-Williams No. T-40 24-inch long stainless steel mop hanger with three rubber spring loaded grips. Acceptable alternative manufacturer: Equal products by C.I.T., Fiat or Oberon.

2.6 SINKS - GENERAL USE - SINGLE COMP. TYPE "SK-A":

A. Elkay LRAD-2521-3, ADA compliant, 25-inch x 21-inch x 5-3/8 inch deep self-rimming, single compartment, 18-gauge type 302 stainless steel sink with 3-faucet holes, one 3-1/2 inch drain hole and fully undercoated underside. Acceptable alternative manufacturer: Equal products by Just or Moen.

B. Chicago Faucet 786-204-725AB ADA compliant, 8-inch center spread, concealed fitting faucet with 5-3/8 inch by 9-3/4 inch tall rigid/swing convertible gooseneck spout, 4-inch wrist blade handles,1.5 gpm laminar flow control insert. The force required to activate the faucet controls shall be no greater than 5. Faucet shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Acceptable alternative manufacturers: Equal products by T&S Brass or Water Saver.

C. Chicago Faucet 1006-ABCP supplies with loose key angle stops, lock shield caps, 1/2" I.P.S. female inlets, wall flanges and 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Equal products by McGuire or Zurn.

D. McGuire No. 1151AWC, ADA compliant, chrome plated offset sink strainer with stainless steel strainer fitting, stainless steel conical strainer basket, neoprene stopper and 1-1/2 inch 17-gauge tubular brass offset tailpiece. Acceptable alternative manufacturers: Equal products by Elkay, Zurn or Just.

E. McGuire No. 8912, 1-1/2" inlet and 1-1/2" outlet adjustable cast brass p-trap with cleanout plug, Type "L" hard drawn copper pipe with IPS brass threaded adapters on both ends to connect from trap to tapped sanitary tee behind wall and Chrome Plated escutcheon at wall. Acceptable alternative manufacturers: Equal products by Elkay, Zurn or Just.

2.7 SINKS - GENERAL USE - DOUBLE COMP. TYPE “SK-B”:

A. Elkay LRAD-3321-3, ADA compliant, 33-inch x 21-inch x 5-3/8 inch deep self-rimming, double compartment, 18-gauge type 302 stainless steel sink with 3-faucet holes, two 3-1/2 inch drain holes and fully undercoated underside. Acceptable alternative manufacturers: Equal products by Just or Moen.

B. Chicago Faucet 786-GN2FCAB ADA compliant, 8-inch center spread, concealed fitting lavatory faucet with 11-1/4 inch by 8-inch tall rigid/swing convertible gooseneck spout, 4-inch wrist blade handles, 1.5 gpm laminar flow control insert. The force required to activate the faucet controls shall be no greater than 5 lb. Faucet shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Acceptable alternative manufacturers: Equal products by T & S Brass or Water Saver.

C. Chicago Faucet 1006-ABCP supplies with loose key angle stops, lock shield caps, 1/2" I.P.S. female inlets, wall flanges and 1/2" O.D. flexible risers with bull-nose outlets. Acceptable alternative manufacturers: Equal products by McGuire or Zurn,.

D. McGuire No. 1151 AWC, or approved equal, ADA compliant, chrome plated offset sink strainer with stainless steel strainer fitting, stainless steel conical strainer basket, neoprene stopper and 1-1/2 inch 7 gauge tubular brass offset tail piece, Acceptable alternative manufacturers: Equal products by Zurn, Elkay or Just.

E. McGuire No. 11C316G17, 1-1/2 inch polished chrome plated, brass, continuous waste or drain connection tubing with end outlet for double compartment sink interconnection. Acceptable alternative manufacturers: Equal products by Just, Elkay or Zurn.

F. McGuire No. 8912, 1-1/2" inlet and 1-1/2" outlet adjustable cast brass p-trap with cleanout plug, Type "L" hard drawn copper pipe with IPS brass threaded adapters on both ends to connect from trap to tapped sanitary tee behind wall and Chrome Plated escutcheon at wall. Acceptable alternative manufacturers: Equal products by Elkay, Zurn or Just.

2.8 WATER CLOSETS - GENERAL TOILET ROOMS

A. (Note: All water closets shall be installed 16 1/2" to 17 1/2" from finished floor to the top of the china rim.)

B. American Standard "AFWALL" No. 2257.001 ADA compliant, 1.28-gpf (high efficiency toilet), white vitreous china, direct-fed siphon jet flushing action, elongated-front, wall-hung, flush valve water closet fixture with 1-1/2 inch top spud. Provide a wall hung bowl meeting the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Water closet fixture shall be designed to flush efficiently with a maximum 1.28-gallons of water total per flush. Toilet must be designed to carry up to 1,000 lb static force. Fixture shall be listed in the State of Texas Water Commission List of Approved Plumbing Fixtures. No wax rings will be permitted on fixtures. Sealing rings shall be resilient rubber. Acceptable alternative manufacturers: Equal products by Kohler or Crane.

C. Zurn Aquaflush ZA6000PL-HET or Sloan Royal 111-1.28 ADA compliant, diaphragm operated, quiet flush, exposed water closet flush valve made of brass with metal oscillating non-hold-open type handle, 1-inch IPS screw driver operated back check angle stop with protective cap, renewable main valve seat, adjustable threaded union tailpiece, vacuum breaker, 1-1/2 inch by 11-1/2 inch flush tube and connection with spud coupling for 1-1/2 inch top spud, spud securing nut, wall and spud flanges, 1-1/2 gallon flush regulator, all with polished chrome finish. Flush control shall be mounted on the wide side of the toilet area. The force required to activate the control shall be no greater than 5. Flush valve assembly shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Flush valve shall be designed to flush efficiently with a maximum 1.28-gallons of water total per flush. Flush valve shall be listed in the State of Texas Water Commission List of Approved Plumbing Fixtures.

D. Bemis Commercial No. 1655SSCT white open front elongated seat with extra heavy duty, less cover, self-sustaining, check hinges, commercial fastening system molded solid plastic, 300 series stainless steel posts, American National Standard Z124.5 compliant. Acceptable alternative manufacturers: Equal products by American Standard, Kohler or Church.

E. Cast iron adjustable water closet carrier with adjustable gasketed faceplate, universal floor mounted foot supports, ABS coupling with integral test cap, rear anchor foot, with flush valve piping support, load rated for 750 lbs, manufactured by Wade 300-series-XH, Acceptable alternative manufacturers: Equal products by Zurn, J.R. Smith or Josam.

2.9 URINALS - GENERAL TOILET ROOMS:

A. All urinals shall be mounted with rim at 24" above finished floor. In toilet rooms designated to be accessible to the handicapped, and no water closets are provided within the same room, all urinals shall be installed with rim at 17" above finished floor. Submittal data shall show height of basin opening and rough-in height. Fixture size, design and mounting height shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Fixture-to-wall sealing rings shall be resilient rubber. Wax sealing rings will not be acceptable.

B. American Standard “Washbrook” No. 6590.001, ADA compliant, 0.125-gallon per flush, white vitreous china, siphon jet flushing action, compact, space-saving, wall-hung, flush valve urinal fixture with 3/4 inch top spud. Provide a urinal fixture measuring a minimum of 14-inches from finished wall to front of flare. Fixture shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Urinal fixture shall be designed to flush efficiently with a maximum 0.125-gallon of water total per flush. Fixture shall be listed in the State of Texas Water Commission List of Approved Plumbing Fixtures. Acceptable alternative manufacturers: Equal products by Kohler or Crane.

C. Zurn AQUAFLUSH Z6003PL-ULF-YK or Sloan ROYAL 186-0.125 HE compliant, diaphragm operated, quiet flush, exposed water closet flush valve made of brass with metal oscillating non-hold-open type handle, 1-inch IPS screw driver operated back check angle stop with protective cap, renewable main valve seat, adjustable threaded union tailpiece, vacuum breaker, 3/4-inch by 11-1/2 inch flush tube and connection with spud coupling for 3/4-inch top spud, spud securing nut, wall and spud flanges, flush regulator, solid ring pipe support all with polished chrome finish. The force required to activate the control shall be no greater than 5. Flush valve assembly shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS). Flush valve shall be designed to flush efficiently with a maximum 0.125-gallon of water total per flush. Flush valve shall be listed in the State of Texas Water Commission List of Approved Plumbing Fixtures.

D. Urinal carrier shall consist of universal hanger plate carrier with pipe uprights, welded base feet and upper plate with hanger support, steel construction, adjustable, flush valve support, lower bearing plate where required, manufactured by Wade 400 series-AM-11 Acceptable alternative manufacturers: Equal products by Zurn. J.R. Smith or Josam.

2.10 SHOWER STALL - ADA COMPLIANT TYPE "SH-A":

A. .

B. Chicago Faucet 1900-VOC-778-009KJK-151-CP built in anti-scald pressure balanced shower valve with integral stops, chrome plated lever handle, wall spout with vacuum breaker and hand and wall shower with 59" flexible rubber lined metal hose, nylon and chrome plated hand spray and 24" adjusting bar with hand shower slide bracket. Pressure balanced shower shall have a piston type cartridge that operates by opening initially through the range of colder temperatures, up to an adjustable maximum high temperature position 1.5 gpm flow restrictor. Diaphragm type pressure balancing valves are not acceptable. Acceptable alternative manufacturers: Equal products by Powers or Symmons,.

2.11 DRINKING FOUNTAINS - TWO LEVEL TYPE "EDF-B":

A. Elkay EZSTL8WSLK ADA compliant, two level, electric drinking fountain with stainless steel fountain top, stainless steel cabinet apron and self-closing push bar located on front and both sides of cabinet, lead free, in-line flow regulator, wall support assembly, with bottle filling station with no-touch sensor with automatic 20 second timer, 1 gpm fill rate. Units shall be ARI certified, with capacity of 8 GPH of 50 degrees F. water 90 degrees F. ambient and 80 degrees F. inlet water. Push bar(s) shall be adjusted for a maximum of 5 pounds pressure to operate. P-trap and supply stop same as specified for lavatory. Acceptable alternative manufacturer: Equal products by Halsey Taylor, Acorn or Oasis

2.12 HOSE BIBBS (HB-A):

A. Chicago Faucet 952CP hose bib, with vacuum breaker, 3/4" hose thread outlet, 3/4" flanged female inlet and removable tee handle with lock shield cap. Acceptable alternative manufacturers: Equal products by T&S Brass or Water Saver.

2.13 VACUUM BREAKERS:

A. All outlets with hose threads shall be provided with vacuum breakers. Where vacuum breakers have not been specified with fixture trim and on all hose faucets not associated with plumbing fixtures both inside and outside of buildings, contractor shall furnish and install 3/4" hose thread vacuum breakers attached to the hose outlet threads with tamper proof set screw. Vacuum breaker shall be as manufactured by Chicago Faucet (E-27 or E-22),. Acceptable alternative manufacturers: Equal products by Watts of Wilkins.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

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. Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with or properly incidental to the installation of complete plumbing fixtures, as indicated on the Drawings, reasonably implied therefrom, or as specified herein, unless specifically excluded.

B. Plumbing fixtures shall be supplied, set and connected as listed herein and as shown on the Drawings. Fixtures shall be protected from damage during construction, and shall be thoroughly cleaned of all tape and adhesives prior to final acceptance.

C. Coordinate special mounting heights of plumbing fixtures with architectural details of each toilet area.

D. Install in accordance with manufacturer's instructions.

E. Install each fixture with trap, easily removable for servicing and cleaning.

F. Install components level and plumb.

G. Install and secure all fixtures in place with specified wall carriers and bolts.

H. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

I. Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.

J. Thoroughly caulk joint between fixtures and walls, countertops and/or floors with waterproof, mold resistant, non-toxic, non-shrinkable white tile caulk.

K. All non-monolithic shower floors shall be provided with drain pan attached to floor drain flange in accordance with plumbing code. Refer to architectural drawings and specifications.

L. Install water supply piping with stop on each supply to each fixture to be connected to water distribution piping.

M. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment, unless sensor operated.

N. Install escutcheons at piping wall and ceiling penetrations in exposed locations, finished locations and with cabinets and millwork.

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 work under provisions of Section 22 00 00.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean work under provisions of 22 00 00.

B. At completion clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Section 22 00 00.

B. Do not permit use of fixtures during construction, until after Substantial Completion has been announced by Owner.

3.8 FIXTURE HEIGHTS

A. Fixture size, design and mounting height shall meet the requirements of ADA, ANSI A117.1 and the State of Texas Accessibility Standards (TAS).

B. Install fixtures to heights above finished floor as indicated.

C. Water-Closet

1. Standard 17 inches to top of bowl rim.

D. Urinal

1. Standard 24 inches to top of bowl rim.

2. Handicapped 17 inches to top of bowl rim (one and only one urinal shall be installed at this height in each location where urinals are installed).

E. Lavatory (wall hung)

1. Standard 32 inches to top of basin rim.

F. Drinking Fountain

1. Standard 36 inches to top of basin rim.

G. Water Closet Flush Valves

1. Standard 10 inches min. above bowl rim.

END OF SECTION 22 40 00

SECTION 23 00 00 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Mechanical Requirements specifically applicable to Division 23 sections, in addition to Division 01 - General Requirements.

1.2 RELATED DOCUMENTS

A. Basic and supplemental requirements common to HVAC.

B. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and Division 01 of the specifications apply to the work specified in this section.

C. All work covered by this section of these specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.3 GENERAL

A. The Contractor shall execute all work herein after specified or indicated on accompanying drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the drawings

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation

C. The Mechanical drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and 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 organized and laid out so that it will be concealed in furred chases, above suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Or where no ceilings exist. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted. All work shall be NFPA compliant and compliant with Insurance Underwriter requirements and guidelines.

D. When the Mechanical drawings do not give exact details as to the elevation of pipe and ductwork, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping is generally intended to be installed true and square to the building construction, The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas, unless there is no ceiling.

1.4 DEFINITIONS

A. These definitions are included to clarify the direction and intention of these Specifications. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner's representative.

1. Concealed / Exposed: Concealed areas are those that cannot be seen by the building occupants. Exposed areas are all areas that are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

2. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements that are included in project. Basic contract definitions are included in the General Conditions.

3. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

4. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

5. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

6. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

7. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

8. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

9. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.05 PERMITS, UTLILITY CONNECTIONS AND INSPECTIONS

A. General: Refer to Division 01 for construction phasing and time increments.

B. Fees and Costs: If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto. If city or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to city controlled services. If inspections by city personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these specifications and drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the specifications and drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.6 CONTRACT DRAWINGS

A. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the specifications, the drawings, and the schedules are as follows: The specifications determine the nature and setting of the several materials, the drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the drawings or specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.7 ALLOWANCES

A. Cash Allowance: Refer to Division 01 of the Construction Documents for information and requirements.

1.8 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.

C. Schedule of Alternates: See "Special Conditions" and Bid Form.

D. Any Alternate Proposals are summarized in Division 01 of the specifications. The Contractor is directed to refer to all sections of the specifications and drawings for this project to determine the exact extent and scope of the various Alternate Proposals as each pertains to the work of all trades.

1.9 SUBMITTALS

A. Refer to Division 1, UGC, and supplemental UGCs for specification requirements pertaining to timeliness of submission and review, quantity, and format. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

B. Proposed Products List: Include Products specified in the following sections:

1. Section 23 05 13 - Motors
2. Section 23 05 16 - Expansion Compensation
3. Section 23 05 29 - Sleeves, Flashings, Supports and Anchors
4. Section 23 05 48 - Vibration Isolation
5. Section 23 05 53 - Mechanical Identification
6. Section 23 05 93 – Testing, Adjusting, and Balancing
7. Section 23 05 93.A – Testing, Adjusting, and Balancing – Contractor Responsibilities
8. Section 23 06 20- Hydronic Specialties
9. Section 23 07 13 - Ductwork Insulation
10. Section 23 07 16 - Equipment Insulation
11. Section 23 07 19 - Piping Insulation
12. Section 23 09 23 - Direct Digital Control Systems
13. Section 23 20 00 - HVAC Pumps
14. Section 23 20 10- Piping, Valves and Fittings
15. Section 23 21 00 - Hydronic Piping
16. Section 23 29 23 – Variable Frequency Drives
17. Section 23 29 23.A – Variable Frequency Drives
18. Section 23 31 00 - Ductwork
19. Section 23 33 00 - Ductwork Accessories
20. Section 23 34 16 - Fans

21. Section 23 36 00 - Air Terminal Units

22. Section 23 37 00 - Air Inlets and Outlets

23. Section 23 41 00 – Filters

24. Section 23 57 00 - Heat Exchangers

25. Section 23 73 23 - Air Handling Units

26. Section 23 82 16 - Air Coils

27. Section 23 82 19 - Terminal Heat Transfer Units

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories clearly marked and/or highlighted, with non-applicable information or data clearly noted in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

1.10 SUBSTITUTION OF MATERIALS AND EQUIPMENT

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment that will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these specifications have been met and samples shall be furnished when requested. All manufacturers' data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the drawings and/or specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the drawings and specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the Architect/Engineer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers' catalogs, sales literature, or incorporated in the shop drawings.

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.11 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.12 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.13 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA)

1. NFPA No. 54, Gas Appliances, Piping, National Fuel Gas Code
2. NFPA No. 70, National Electrical Code
3. NFPA No. 72D, Proprietary Signaling Systems
4. NFPA No. 90A, Air Conditioning Systems
5. NFPA No. 91, Blower & Exhaust Systems
6. NFPA No. 99, Health Care Facilities

7 NFPA No. 101, Life Safety Code

8. NFPA No. 211, Chimneys, Fireplaces, Vent Systems

9. NFPA No. 241, Standard for Safeguarding Construction, Alteration and Demolition Operations

10. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials

13. NFPA No. 258, Standard Research Test Method for Determining Smoke Generation of Solid Materials

C. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards

D. American National Standards Institute (ANSI)

1. B31.1, Power Piping
2. B9.1, Safety Code for Mechanical Refrigeration

E. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these specifications.

F. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

G. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards

H. National Electrical Manufacturers' Association (NEMA): All current editions of applicable manuals and standards.

I. International Mechanical Code

J. Texas Occupational Safety Act: All applicable safety standards.

K. Occupational Safety and Health Act (OSHA).

L. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

M. Refer to specification sections hereinafter bound for additional Codes and Standards.

N. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. In all cases where Underwriters Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL "label" or "listing" under Re-Examination Service.

O. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations

1.14 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot dip galvanized, mill galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.15 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other sections. Obtain permission of Owner, Architect/Engineer before proceeding.

1.16 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer's published directions shall be followed in the delivery, storage, protection, installation, testing, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturer’s directions, and shall obtain the Architect/Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer’s directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.17 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of Fire Protection equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.18 LARGE APPARATUS

A. Any large piece of apparatus that is to be installed in any space in the building, and that is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.19 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.

1.20 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.21 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. The Contractor shall note that the electrical design and drawings are based on the equipment scheduled and indicated on the drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The electrical trades shall provide all interconnecting wiring for the installation of all power. The electrical trades shall provide all disconnect switches as required for proper operation, as indicated on the drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 26.

C. Provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the electrical trades by the Contractor.

1.22 SUPERVISION

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the drawings, the matter shall be referred to the A/E for ruling.

1.23 SITE OBSERVATION

A. Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Contract Documents, and shall not be construed as construction supervision nor indication of approval of the manner or location in which the work is being performed as being a safe practice or place.

1.24 INSTALLATION METHODS

A. Where to Conceal: All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All pipes run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping."

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 5 working days or as agreed by the Project Manager.

3. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures shall be complete and installed in accordance with contract requirements, including power to fans, and other powered items. Adequate lighting shall be provided to permit thorough inspection of all above ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager's Construction Inspector(s), the Resident Construction Manager, and Office of Facilities Planning and Construction (OFPC). Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.25 RECORDS FOR OWNER

A. The Contractor shall maintain a set of "blueline" prints in the Field Office for the sole purpose of recording "installed" conditions. Daily note all changes made in these drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At contract completion, the Contractor shall provide an electronic file of the revised drawings. The contractor shall transfer the information from the "blueline" prints maintained as described above, and turn over this neatly marked set of reproducible drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these specifications, and to the Uniform General Conditions, for additional information. These drawings shall include as a minimum:

1. Addendum written drawing changes.

2. Addendum supplementary drawings.

3. Accurate, dimensioned locations of all underground utilities, services and systems.

4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.

5. Change Order written drawing changes.

6. Change Order supplementary drawings.

C. Electronic Media

1. The contractor shall submit three compact discs containing all the drawings in AUTOCAD 12 or 14 format.

D. "As installed" plans shall bear a stamp, "stick-on decal" or lettered title block generally located in lower right hand corner of drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.

2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.

3. Valve tag charts and diagrams specified herein.

4. Approved wiring diagrams and control diagrams representing "as installed" conditions.

5. Copies of approved shop drawings.

6. Any and all other data and/or drawings required as submittals during construction.

7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

1.26 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate specification section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

E. Plaster: All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

F. Special Note: No cutting, boring, or excavating that will weaken the structure shall be undertaken.

1.27 ROOF PENETRATIONS AND FLASHING

A. Pipe, sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.28 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the drawings and/or required for the installation of piping. All exterior lines shall be installed with a minimum cover of 24," unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room to complete the pipe joint . Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6" below the trench depths specified. The over depth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for water lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

B. Backfilling

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one-foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

C. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of it. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.29 OPERATION PRIOR TO COMPLETION

A. When any piece of Fire Protection equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Project Manager’s written permission to do so. The warranty period shall, however, not commence until the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust and complete all deficiency list items prior to being started, commissioned and before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.30 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workers, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall them upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction. This is to include but is not limited to temperature controls system devices, electrical switches, relays, fixtures, and piping.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner two weeks in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, coordination meetings shall be included in the contract amount.

1.31 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workers skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities that must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

1.32 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

A. Check inspections shall include heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.33 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.34 CLEANING AND PAINTING

A. All equipment and piping, etc., furnished and installed in exposed areas under Division 23 of these specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Division 23 work.

B. All purchased equipment shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.

C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metalwork shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

D. Color of finish painting shall be painted in accordance with The University of Texas Standard Color Schedule for machinery spaces using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

ITEM	COLOR	"P and L" PAINT NUMBER
Piping (Insulated and Uninsulated)	Light Gray	B798M (London Fog)
Hanger Rods	Same as "Piping" above	
Steam Traps and Metal Exposed to High Temperatures	Same as "Piping" above, high temp rated	
Atmospheric Relief Line	Same as "Piping" above	
Ductwork, AHU, Fans and Insulation	Buff	Y354M (Tawny Gold)
Valve Hand Wheels	Blue	B726M (Siam Blue)
Pump Couplings and	Safety Yellow	Y361M (Daisy Yellow

E. Jacketing on insulation shall not be painted.

F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

G. Scope of painting for Division 23--work in areas other than those defined as "exposed" is as follows:

1. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers in underfloor spaces shall be cleaned and painted with two coats of Tropical Paint Co. No. 77-black asphaltic emulsion. Galvanized steel and copper lines in these spaces shall not be painted.

2. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.

3. All fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA.

4. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.

C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the Contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of Work involved. All Work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job Site but shall be replaced with new materials and/or equipment.

E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with Contract Documents.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.2 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

B. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.

C. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.

D. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.

1. Individual Starters, Contactors, Disconnect Switches, and Similar Equipment: Identify the device, and voltage characteristics source and load served.

2.3 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.

B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.

C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.

D. Plates will not be required for piping where pipe sleeves extend ¾-inch or more above finished floor.

2.4 ACCESS DOORS

A. General: This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of mechanical equipment or devices.

B. Doors: Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacture, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surface of the adjacent finishes. Access doors mounted on tile surfaces shall be of similar construction as noted above, except they shall be of stainless steel materials. Access doors shall be a minimum of 12" x 12" in size.

2.5 ROOF PENETRATIONS AND FLASHING

A. Pipe sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such Work. Installation shall comply with the Contract Documents and with FM General Data Sheets 1-28, 1-29, 1-31 & 1-49 along with the FM approval guide.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this Work in order to effect timely and accurate placing of Work and to coordinate, in proper and correct sequence, the Work of such trades.

B. The size of equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine that the equipment proposed will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

D. Space Requirements:

1. Consider space limitations imposed by contiguous Work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the Owner.

E. Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations, as shown on the drawings and stated in the specifications.

C. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.

D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.

E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.

F. Precedence of Materials:

1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.

2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":

a. Building lines

b. Structural members

c. Structural support frames supporting ceiling equipment

d. Electric tracked vehicle system

e. Pneumatic trash and linen system

f. Pneumatic tube system

g. Soil and drain piping

h. Vent piping

i. Supply, return and outside air ductwork

j. Exhaust ductwork

k. HVAC water and steam piping

l. Condensate piping

m. Fire protection piping

n. Natural gas piping

o. Medical/Laboratory gases

p. Domestic water (cold and hot, softened, treated)

q. Refrigerant piping

r. Electrical conduit

3. Coordinate fire protection system with other trade systems as required to maintain system right-of-ways.

3.3 TESTING

A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, Contractor may do so, provided that Contractor properly supervises the operation, and has the Project Manager's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of Substantial Completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean and properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

C. The Contractor shall execute, at no additional cost to the Owner, any tests required by the Owner or the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials and labor for making such tests. The Owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the Owner, will be borne by the Owner.

D. Notify the Project Manager and the Architect/Engineer in writing at least five (5) calendar days or as agreed by the Project Manager prior to each test and prior to other Specification requirements requiring Owner and Architect/Engineer to observe and/or approve tests.

E. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results an other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The Contractor or Contractor's authorized job superintendent shall legibly sign all Test Log entries.

F. Maintain Log of Tests as hereinafter specified.

G. See specifications hereinafter for additional tests and requirements.

H. Refer to Commissioning Specification Sections for additional Start-up, prefunctional and operational checkout, and for functional performance test procedures.

3.4 PIPING PRESSURE TESTS

A. The following lines shall be tested at the stated pressure for the length of time noted:

Testing Service	Testing Medium	Pressure (PSIG)	Time in Hours
Chilled Water	Water	150	241
Pumped Condensate Return	Water	150	24

B. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled “Project Closeout Procedures.”

3.5 TRAINING

A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled “Project Closeout Procedures.”

END OF SECTION 21 00 00

SECTION 23 01 00 – MECHANICAL/ HVAC 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. Action Submittals: Written and graphic information and physical samples that require Engineer’s responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Division Section as "informational submittals."

C. 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.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of Division 23 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 Engineer’s 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 startup 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.
4. Format: Arrange the following information in a tabular format:
   a. Scheduled date for first submittal.
   b. Specification Section number and title.
   c. Submittal category: Action; informational.
   d. Name of subcontractor.
   e. Description of the Work covered.
   f. Scheduled date for Engineer's final release or approval.
   g. Scheduled date of fabrication.
   h. Scheduled dates for delivery.
   i. Scheduled dates for installation.
   j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.
   1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing and Project record drawings.
      a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
      b. Contractor shall execute a data licensing agreement in the form of Halff Associates' Standard form.

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 all submittal items required for each Specification Section within a Construction Division concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
      - This submittal package shall be comprehensive document by Division and not piecemealed by specification section.
   3. Submit action submittals and informational submittals required by the same Specification Section concurrent.
   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. For example, HVAC Equipment must be submitted and approved prior to approval of Electrical gear.
      a. Engineer 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, as follows. Time for review shall commence on Engineer'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 15 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
   2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
   3. Resubmittal Review: Allow 10 working days for review of each resubmittal.

4. Sequential Review: Where sequential review of submittals is indicated, allow 15 working days for initial review of each submittal.

D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
   1. Indicate name of firm or entity that prepared each submittal on label or title block.
   2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
   3. Include the following information for processing and recording action taken:
      a. Project name.
      b. Date.
      c. Name of Engineer.
      d. Name of Construction Manager, where applicable.
      e. Name of Contractor.
      f. Name of subcontractor.
      g. Name of supplier.
      h. Name of manufacturer.
      i. Submittal number or other unique identifier, including revision identifier.
         1) Submittal number shall use Specification Division Section or number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
      j. Number and title of appropriate Specification.
      k. Drawing number and detail references, as appropriate.
      l. Location(s) where product is to be installed, as appropriate.
      m. Other necessary identification.
   4. Additional Paper Copies: Unless additional copies are required for final submittal, initial submittal may serve as final submittal.
      a. When paper copies are required, submit one copy of submittal.
   5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return without review submittals received from sources other than Contractor.
      a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
         1) Project name.
         2) Date.
         3) Destination (To:).
         4) Source (From:).
         5) Name and address of Engineer.
         6) Name of Construction Manager, where applicable.
         7) Name of Contractor.
         8) Name of firm or entity that prepared submittal.
         9) Names of subcontractor, manufacturer, and supplier.
         10) Category and type of submittal.
         11) Submittal purpose and description.
         12) Specification Section number and title.
         13) Specification paragraph number or drawing designation and generic name for each of multiple items.
         14) Drawing number and detail references, as appropriate.
         15) Indication of full or partial submittal.
         16) Transmittal number, numbered consecutively.
         17) Submittal and transmittal distribution record.
         18) Remarks.
         19) Signature of transmitter.

E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
   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. Alternately, submit package as a comprehensive .pdf document by Division with each Specification Section tabbed.
   2. Name file with submittal number or other unique identifier, including revision identifier.
      a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
   3. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:
      a. Project name.
      b. Date.
      c. Name and address of Engineer.
      d. Name of Construction Manager, where applicable.
      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.

F. Options: Identify options requiring selection by Engineer.

G. 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 Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

H. 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 Engineer’s action stamp.

I. 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.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer’s action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
   1. Post electronic submittals as PDF electronic files directly to Project Web site or FTP site specifically established for Project.
      a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
   2. Action Submittals: For submittal formats 11 x 17 and larger, submit two paper copies of each submittal unless otherwise indicated in addition to the electronically posted submittal. Engineer will return one copy of paper submittal.
   3. Certificates and Certifications Submittals: Provide a 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 construction Division 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 (8-1/2 x 11 format only) in the following format:
      a. 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 sheets at least 11 x 17 but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:
   a. Two opaque (bond) copies of each submittal. Engineer will return one copy. Submit also one electronic file for record keeping.
4. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.
   a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.
   b. Refer to Section 01 31 00 "Project Management and Coordination" for requirements for coordination drawings.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these 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 for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
   a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. "Samples for Verification" Subparagraph below can be used with or without Samples for initial selection. Revise to suit Project.

E. LEED Submittals: Comply with requirements specified in Section 01 81 13.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations," Section 01 81 13.16 "Sustainable Design Requirements - LEED for Commercial Interiors," Section 01 81 13.19 "Sustainable Design Requirements - LEED for Core and Shell Development," and Section 01 81 13.23 "Sustainable Design Requirements - LEED for Schools."

F. 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.

G. 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.

H. 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.

I. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

J. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

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 Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file 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 following format: 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 Engineer.

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 ENGINEER'S ACTION

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer 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 Engineer.

C. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

D. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 23 01 00

SECTION 23 05 13 – MOTORS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Single phase electric motors

B. Three phase electric motors

C. The Contractor shall provide all motors required for equipment supplied under this Division of the work

1.3 RELATED WORK

A. Section 23 20 00 - HVAC Pumps

B. Section 23 82 19 - Terminal Heat Transfer Units: Unit heaters, fan-coil units, and unit ventilators

C. Section 23 73 23 - Air Handling Unit: Fan motors

D. Section 23 34 16 - Fans

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators

D. ANSI/NEMA MG 1 - Motors and Generators

E. ANSI/NFPA 70 - National Electrical Code

1.5 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00

B. Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and larger.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three–years documented product development, testing, and manufacturing experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY

A. Provide five year manufacturer's warranty under provisions of Section 23 00 00.

B. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Open Design Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

B. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.

C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.

E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

F. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.

G. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

H. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

I. Dynamic Balance shall be no greater than the vibration limits of the driven equipment.

J. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

2.2 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with drip-proof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.4 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.5 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Acceptable Manufacturers: Subject to conformance with these specifications, furnish motors by one of the following manufacturers:

1. Baldor
2. TECO/Westinghouse
3. Toshiba
4. General Electric

B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage premium efficiency induction type with standard NEMA frame sizes.

C. All three phase motors shall be inverter duty rated and equipped with a shaft grounding device. Inverter duty motors shall be capable of withstanding repeated peaks of 1600 volts at 0.1 microsecond rise time and comply with NEMA MG-1 Part 31.

D. Motors 1 HP and larger shall have integral frames.

E. Starting Torque: Between one and one and one-half times full load torque.

F. Starting Current: Six times full load current.

G. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B Characteristics.

H. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.

I. Insulation System: NEMA Class B or better.

J. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.01J.

K. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

L. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter or VFD; refer to Division 26 for Starter Requirements. Refer to Specification Section 23 29 23 for Variable Frequency Drives.

M. Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory pre-packed with a non-detergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for L-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

N. Sound Power Levels: Refer to ANSI/NEMA MG 1.

O. Weatherproof Epoxy Treated Motors (Where Indicated): Epoxy coat windings with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

P. Nominal Efficiency: Furnish all motors with minimum efficiency equal to or greater than Efficiency Level of Premium Efficiency Motors as defined in the latest version of NEMA MG-1.

Q. Service Factor: M Furnish all motors with service factor equal to or greater than that required in the latest version of NEMA MG-1

R. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

PART 3 - EXECUTION

3.1 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, unless specified otherwise.

C. Motors larger than 1/20hp shall be of the following D0G, to suit starting torquie and requirements of specific motor application.

D. Single phase motors for shaft mounted fans, oil burners, 0000000centrifugal pumps shall be split phase type.

E. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

F. Single phase motors for fans pumps, blowers, air compressors shall be capacitor start type.

G. Single phase motors for fans, blowers, pumps shall be capacitor start, capacitor run type.

H. Motors located in air-cooled condensers shall be totally enclosed type.

END OF SECTION 23 05 13

SECTION 23 05 16 – EXPANSION COMPENSATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

D. Section 23 20 00.A – Pipes, Valves, and Fittings

1.2 SECTION INCLUDES

A. Flexible pipe connectors

B. Expansion joints and compensators

C. Pipe loops, offsets, and swing joints

1.3 RELATED SECTIONS

A. Section 23 21 00 - Hydronic Pumping

B. Section 23 23 00 - Refrigerant Piping and Specialties

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.

B. Expansion Calculations:

1. Installation Temperature: 50 degrees F.

2. Chilled water: 42 degrees F.

3. Safety Factory: 30 percent.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00 .

B. 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.

C. Samples: Submit two low pressure compensators 1 inch in size.

D. Design Data: Indicate selection calculations.

E. Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00.

B. Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include adjustment instructions.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Provide five-year warranty.

B. Warranty: Include coverage for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS

A. Provide two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

A. Steel Piping:

1. Manufacturers:

a. Metraflex

b. Flex-Weld

c. Flexicraft

2. Inner Hose: ASTM Grade 304, 316, or 321 Stainless Steel.

3. Exterior Sleeve: Double braided ASTM Grade 304, 316, or 321 stainless steel.

4. Pressure Rating: 150 psig WOG at 250 degrees F for circulating water systems; 125 SWP at 400 F for steam

5. Joint: As specified for pipe joints.

6. Size: Use pipe sized units.

7. Maximum offset: 3/4 inch on each side of installed center line.

8. Application: Pump connections and vibration isolating connections on steel circulating water systems.

B. Single/Double Flexible Sphere :

1. Manufacturers:

a. Metraflex

b. Flex-Weld

c. Kinetics Noise Control

2. Body: EPDM (Teflon)

3. Working Pressure: 225 psi at 170 F

4. Maximum Temperature: 225 degrees F.

5. Maximum Compression: Single sphere: 1/2 inch; double sphere: 1 3/4 inches

6. Maximum Elongation: Single sphere: 1/8 inch; double sphere: 1/2 inch

7. Maximum Offset: Single sphere: 3/8 inch; double sphere: 3/4 inch

8. Maximum Angular Movement: 15 degrees.

9. Joint: As specified for pipe joints.

10. Size: Use pipe sized units.

11. Accessories: Control rods or control cables to prevent overextension

12. Application: Pump connections and vibration isolating connections on circulating water systems.

C. Copper Piping:

1. Manufacturers:

a. Metraflex

b. Flex-Weld

c. Flexicraft

2. Inner Hose: Bronze

3. Exterior Sleeve: Double-braided bronze.

4. Pressure Rating: 150 psig WOG and 250 degrees F.

5. Joint: As specified for pipe joints.

6. Size: Use pipe sized units.

7. Maximum offset: 3/4 inch on each side of installed center line.

8. Application: Pump connections and vibration isolating connections on copper circulating water systems.

2.2 FLEXIBLE HOSE EXPANSION LOOPS

A. General Requirements:

1. All flexible pipe connectors shall be double braided.

2. Stainless steel flexible pipe connectors shall be used with steel pipe; bronze flexible pipe connectors shall be used with copper pipe.

3. Flexible hose expansion loops shall be manufactured complete. Field fabricated loops are not acceptable.

4. Flexible hose expansion loop shall impart no thrust loads to system supports, anchors, or the building structure.

5. All flexible hose expansion loops shall be manufactured in accordance with ASME BPVC Section IX.

6. Flexible expansion loops shall have a factory supplied, hanger/support lug located at the bottom of the 180 degree return.

7. Flexible expansion loops shall be furnished with a plugged FPT fitting for a vent or drain. For pipes 1”—6”, the fitting shall be 3/8” FPT; for pipes 8” and larger, the fitting shall be ½” FPT.

8. On steam systems, hose shall be installed horizontally with a drip leg and steam trap upstream of compensator.

B. Piping:

1. Manufacturers:

a. Metraflex

b. Flex-Weld

c. Flexicraft

2. Inner Hose: ASTM Grade 304, 316, or 321 Stainless Steel.

3. Exterior Sleeve: Double braided ASTM Grade 304, 316, or 321 stainless steel.

4. Pressure Rating: 150 psig WOG at 250 degrees F for circulating water systems; 125 SWP at 400 F for steam

5. Joint: As specified for pipe joints.

6. Size: Use pipe sized units.

7. Maximum offset: 3/4 inch on each side of installed center line.

8. Application: steel circulating water systems and low and medium pressure steam systems.

C. Copper Piping:

1. Manufacturers:

a. Metraflex

b. Flex-Weld

c. Flexicraft

2. Inner Hose: Bronze

3. Exterior Sleeve: Double-braided bronze.

4. Pressure Rating: 150 psig WOG and 250 degrees F.

5. Joint: As specified for pipe joints.

6. Size: Use pipe sized units.

7. Maximum offset: 3/4 inch on each side of installed center line.

8. Application: copper circulating water systems.

2.3 EXPANSION JOINTS

1. Stainless Steel Bellows Type: Manufacturers:

a. Metraflex

b. Unaflex

c. Flex-Weld

d. Flexicraft

2. Bellows material shall be ASTM Grade 304, 316, or 321.

3. Pressure Rating: 125 psig WSP and 400 degrees F for low and medium pressure steam; 150 psig WOG and 250 degrees F for circulating water.

4. Maximum Compression: 1 1/2”

5. Maximum Extension: 1/4”.

6. Joint: As specified for pipe joints.

7. Size: Use pipe sized units.

8. Application: Steel piping 3 inch and under where expected thermal expansion is less than 1 ½". When used for chilled water, bellows shall be preloaded to expected contraction distance per expansion calculations.

2.4 ACCESSORIES

A. Pipe Alignment Guides:

1. Manufacturers:

a. Metraflex

b. Flexicraft

c. Twin City Hose, Inc.

2. 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 in accordance with manufacturer's instructions.

B. Construct spool pieces to exact size of flexible connection for future insertion.

C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where indicated.

G. Provide expansion loops as indicated on drawings.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Section 23 00 00.

B. Provide inspection services by flexible pipe manufacturer's representative for final installing and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 23 05 16

SECTION 23 05 29 – SLEEVES, FLASHINGS, SUPPORTS, AND ANCHORS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Sleeves and seals

D. Flashing and sealing equipment and pipe stacks

1.3 RELATED SECTIONS

A. Section 03300 Cast In Place Concrete: Equipment bases

B. Section 07 84 00 Firestopping: Joint seals for piping and duct penetration of fire rated assemblies

C. Section 09 91 00 Painting

D. Section 23 05 4 Vibration Isolation

E. Section 23 07 19 Piping Insulation

F. Section 23 07 16 Equipment Insulation

G. Section 23 07 16 Ductwork Insulation

H. Section 23 21 00 Hydronic Piping

1.4 REFERENCES

A. ASME B31.1 Power Piping

B. ASME B31.5 Refrigeration Piping

C. ASME B31.9 Building Services Piping

D. ASTM F708 Design and Installation of Rigid Pipe Hangers

E. MSS SP58 Pipe Hangers and Supports Materials, Design and Manufacturer

F. MSS SP69 Pipe Hangers and Supports Selection and Application

G. MSS SP89 Pipe Hangers and Supports Fabrication and Installation Practices

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of hydronic, steam and steam condensate piping.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

A. Manufacturers:

1. Anvil
2. Kindorf
3. B-Line
4. Power Strut

B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc. The hanger design shall conform to the ASME Code for Pressure Piping.

C. All auxiliary steel required for supports, anchors, guides, etc. shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.

D. The supports, hangers, anchors, and guides for the chilled water supply and return piping shall be provided as indicated on the Drawings.

E. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.

F. All Supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.

G. All rod sizes indicated in this Specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc. All structural hanging materials shall have a minimum safety factor of 5 built in.

H. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.

I. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.

J. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

K. Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Anvil Fig. CT-65 , adjustable, copper plated, clevis hanger. Hangers supporting and contacting brass or copper lines 4" and larger shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Anvil Fig. 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod. Isolate all copper or brass lines from all ferrous materials with approved dielectric materials. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal. The padding material and the configuration of its installation shall be submitted for approval.

L. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8" diameter pipe or smaller in size and supporting all ferrous lines 6" and smaller in size shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

M. Hangers supporting and contacting ferrous lines larger than 6" in size and outside of insulation on lines with the outside diameter equivalent to 10" diameter pipe shall be Anvil Fig. 260, adjustable clevis, with a nut above and below the hanger on the support rod.

N. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

O. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support shields as specified in Section 23 07 19 PIPING INSULATION. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.

P. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Anvil Fig. 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor. Two hole rigid pipe clamps at 4 ft. o.c. or Kindorf channels and Anvil Fig. 261 riser clamps may be used to support pipe directly from vertical surfaces or members where lines are not subject to expansion and contraction. When piping is subject to expansion and contraction, provide spring isolators (see Section 23 05 48 - Vibration Isolation). Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

Q. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure. The contractor shall use a drilled anchor as specified above, and use an Anvil No. 595 Socket Clamp with Anvil No. 594 Socket Clamp Washers, as a riser clamp. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser.

R. Pipe Supports in Chases and Partitions: Horizontal and vertical piping in chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles, or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp, or other approved method. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action.

S. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

T. Vibration Isolation: Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc.). Piping or ductwork that may vibrate and create an audible noise shall also be isolated. Spring hangers or supports shall be provided where indicated on the Drawings and/or specified under Section 23 05 48.

U. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.

2. Inserts shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.

3. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc. All piping shall be installed with due regard to expansion and contraction and the type of hanger method of support, location of support, etc. shall be governed in part by this Specification.

4. Hangers shall be attached to the structure as follows:
   a. Poured In Place Concrete: Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I beam, etc. spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.
   b. Steel Bar Joists: Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts. Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed thereto.
   c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
   d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.
   e. Pre Cast Tee Structural Concrete: Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only. Holes required for

hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15" of each stem and in the "shadow" of the stem on the top side of the "double tees."

f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.

g. Note: Power actuated fasteners (shooting) will not be acceptable under any circumstances.

h. Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

V. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Anvil, Kindorf, Uni-Strut, Power Strut, or approved equal, channel suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

W. Finishes: All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, and brackets, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. Universal concrete inserts shall be cadmium plated.

X. Ductwork: All ductwork shall be supported in accordance with the SMACNA recommendation for the service involved; however, all horizontal ductwork shall be supported at intervals not to exceed the scheduled values indicated elsewhere in this section. Horizontal ducts shall be supported using galvanized steel bands extending up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete bolted to angles secured to the construction above, or secured in another approved manner. For attaching methods for precast double tee structural concrete, refer to details on the Drawings and as specified herein.

Y. Terminal units shall be supported by four 16 gauge, 1" wide sheet metal straps which shall be folded under the bottom of the casing a minimum of 1". Attach each strap to bottom of terminal unit with two sheet metal screws not larger than ¾" in length and not more that ¼" in diameter. The straps shall be attached to the structure by a ¼" diameter threaded bolt into a concrete insert or into a drilled hole with a threaded concrete expansion anchor. Where interferences occur, overhead of the box, not allowing direct vertical support by straps, provide trapezes of Kindorf, Unistrut, or B-Line channel suspended by 1/4" diameter galvanized threaded rods providing such channels do not block access panels of boxes. Threaded rods shall be supported from structure by concrete insert or by drilled-hole threaded concrete expansion anchor.

Z. Miscellaneous: Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

2.2 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

B. Inserts: 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. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

2.3 FLASHING AND EQUIPMENT CURBS

A. Metal Flashing: 26 gauge galvanized (stainless steel) steel.

B. Metal Counterflashing: 22 gauge galvanized (stainless steel) steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

E. Curbs: Welded 18 gauge galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, factory installed wood nailer.

2.4 CONCRETE FOUNDATIONS ("HOUSEKEEPING PADS"):

A. Concrete foundations for the support of equipment such as floor mounted panels, pumps, fans, air handling units, etc., shall extend 4" on all sides beyond the limits of the mounted equipment unless otherwise noted and shall be poured in forms built of new dressed 6" nominal lumber. All corners of the foundations shall be neatly chamfered by means of sheet metal or triangular wood strips nailed to the form. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, the forms shall be removed and the surface of the foundations shall be hand rubbed with carborundum. Foundations for equipment located on the exterior of the building shall be provided as indicated. Foundations shall be constructed in accordance with Shop Drawings submitted by the Contractor for review by the Architect/Engineer.

2.5 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations. Floor penetrations in exposed (except in stair wells) areas shall be finished using 'bell' fitting to fit pipe or insulation and sleeve and shall be painted to match the pipe. Penetrations in stairwells shall have flat floor plate painted to match pipe.

2.6 SLEEVES

A. General: All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved. All penetrations must pass through sleeves. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the

Architect/Engineer. If a penetration is cored into an existing vertical solid concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

1. Sleeve material for floors and exterior walls shall be Schedule 40 galvanized steel with welded water stop rings.

2. Sleeves through interior walls to be galvanized sheetmetal with gauge as required by wall fire rating, 20 gauge minimum.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4", except that the minimum clearance shall accommodate a Thunderline Link seal closure where piping exits the building, or penetrates a wall below ground level. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc. All penetrations shall be of ample size to accommodate the pipe, duct, etc., plus any specified insulation. Void between sleeve and pipe in interior penetrations shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

C. Floor sleeves shall extend above the finished floor as detailed on the drawings, except that floor sleeves in stairwells shall be flush with the finished floor. Sleeves in walls shall be trimmed flush with wall surface. Refer to the details on the project drawings. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Vermin proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be vermin proofed in a manner acceptable to the Architect/Engineer.

F. Waterproofing: The annular space between a pipe and its sleeve in interior floors shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of floor.

G. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

H. Fireproofing: Seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2000□ F for two hours. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed. For wet locations, the foam material shall be a silicone RTV foam or an approved equal. For dry locations, a premixed putty equal to Nelson Flameseal Firestop putty may be used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide 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 over 4 inches.

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 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

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 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple 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. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating. Repair any damaged galvanized plating with a coating of 'Galvalum'.

L. Hanger Rods: (NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage.)

3.4 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 14 inches minimum high above roofing surface. Flash and counterflash 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.

3.5 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors (except in stairwells) two inches above finished floor level. Sleeves through floors shall have welded waterstop rings. Sleeves shall be sealed watertight to floors and pipe.

D. Where piping, ductwork or conduit penetrates floor, ceiling, or wall, close space between pipe or duct and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.6 PIPE SUPPORT SCHEDULES

STEEL PIPE SIZE Inches	MAX HANGER SPACING Feet	HANGER ROD DIAMETER Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
8 to 12	14	7/8
14 and Over	20	1

3.7 LOW PRESSURE DUCT SUPPORT SCHEDULE:

A. All horizontal ducts up to and including 40 inches in their greater dimension shall be supported by means of No. 18 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets, or clamps and fastened to above inserts with toggle bolts, beam clamps or other approved means. Duct shall have at least one pair of supports 8' 0" on centers. Clamps shall be used to fasten hangers to reinforcing on sealed ducts.

B. Horizontal ducts larger than 40 inches in their greatest dimension shall be supported by means of hanger rods bolted to angle iron trapeze hangers. Duct shall have at least one pair of supports 8' 0" on centers according to the following:

Length	Angle	Rod Diameter
4’ 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
6' 0"	1-1/2" x 1-1/2" x 1/8"	1/4"
8' 0"	2" x 2" x 1/8"	5/16"
10' 0"	3" x 3" x 1/8"	3/8"

C. Vertical ducts shall be supported where they pass through the floor lines with 1 1/2" x 1 1/2" x 1/4" angles for ducts up to 60.” Above 60", the angles must be increased in strength and sized on an individual basis considering space requirements.

3.8 MEDIUM PRESSURE DUCT SUPPORT SCHEDULE:

A. All horizontal rectangular ducts shall have duct hanger requirements as follows:

Minimum Hanger Size					
Max Duct Dimen.	Steel Rod	Galvanized Steel Strap Width	Max Spacing	Min # of Hangers	Trapeze Size
0 through 18"	--	1" x 16 ga.	10'	2	--
19" through 36"	--	1" x 16 ga.	10'	2	--
37" through 60"	3/8"	1" x 16 ga.	8'	2	2" x 2" x 1/4"
61" through 120"	3/8"	1-1/2" x 12 ga.	8'	2	2" x 2" x 1/4"
121" through 240	3/8"	--	4'	3	2-1/2" x 2-1/2" x 3/16"

B. All horizontal round ducts shall have ducts hangers spaced 10' 0" maximum with requirements as follows:

Duct Diameter	Min. Hanger Size	No. Hangers	Hanger Ring Size
Up through 18"	1" x 16 gauge	1	1" x 16 ga.
19" to 36"	1" x 12 gauge	1	1" X 12 ga.
37" to 50"	1-1/2" x 12 gauge	1	1-1/2" x 12 ga.
51" to 84"	1-1/2" x 12 gauge	2	Support Bracing Angle

3.9 DUCT HANGERS - GENERAL NOTES (ALL PRESSURES)

A. Hanger straps on duct width of 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the side.

B. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8" bolts minimum.

C. Use 3/8" minimum bolts for securing duct hanger to band straps.

D. All round ducts shall be supported within 3 feet of all horizontal or vertical turns.

END OF SECTION 23 05 29

SECTION 23 05 48 – VIBRATION ISOLATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors

C. 23 05 53 -- Mechanical Identification

1.2 WORK INCLUDED

A. Vibration isolation

B. Inertia bases

1.3 SCOPE OF WORK:

A. Furnish and install all labor, materials, equipment tools and service and perform all operations required in connection with or properly incidental to the construction of complete system of vibration and noise control, as indicated on the Drawings, reasonably implied therefrom or as specified herein, unless specifically excluded.

1.4 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves

1.5 QUALITY ASSURANCE

A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Indicate inertia bases on shop drawings.

C. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.

D. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.7 CERTIFICATES

A. Submit a certificate from the manufacturer that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

1.8 INTENT OF RESPONSIBILITY:

A. It is the intent of this specification to provide for vibration isolation supports for all equipment, piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the

transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria, and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Concrete housekeeping pads and inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.

C. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

PART 2 - The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect, or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

PART 3 - PRODUCTS

3.1 MANUFACTURERS:

A. Vibration isolation devices shall be as manufactured by Vibration Mountings & Controls Inc (VMC), Kinetics Noise Control, or approved equal.

3.2 GENERAL DESIGN FEATURES:

A. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.

B. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cadmium plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

C. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized, or zinc-electroplated and shall have a coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.

D. Required spring deflections for isolators supporting various items of equipment are shown on the

Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.

E. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

F. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".

G. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

H. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

3.3 ISOLATOR TYPES: ISOLATOR TYPES AND REQUIRED DEFLECTIONS ARE SPECIFIED UNDER "SCHEDULE OF ISOLATED EQUIPMENT," PARAGRAPH 3.2. THE ISOLATORS SHALL COMPLY WITH THE FOLLOWING DESCRIPTIONS FOR EACH TYPE REQUIRED ON THE PROJECT:

A. Type 1 - An adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring(s) shall be rigidly attached to the mounting base plate and to the spring compression plate. The isolator shall be designed for a minimum Kx/Ky (horizontal to vertical spring rate) of 1.0. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate. Base plates shall be sized to limit pad loading to 100 psi.

B. Type 2 - An aluminum-housed, or cast iron housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Sheet or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the base plate.

C. Type 3 - An elastomeric mounting having steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric materials. The elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives. Mountings shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

D. Type 4 - A pad-type mounting consisting of two layers of 3/8" thick, ribbed or waffled, Neoprene pads bonded to a 16 gauge galvanized steel separator plate. Bolting not required. Pads shall be sized for approximately 20 to 40 psi load, or a deflection of 0.10" to 0.16".

E. Type 5 - A spring hanger consisting of a rectangular steel box, coil springs, spring cups, Neoprene impregnated fabric washer, steel washer, and Neoprene insert designed to prevent metal to metal contact between the hanger rod and bottom of the hanger box. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.

F. Type 6 - A spring hanger, as described in Type 5, with the addition of an elastomeric element at the top of the box for acoustic isolation. The design shall be such to prevent metal - to metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type 3 mountings.

G. Type 7 - An elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additive. The elements shall be so designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

H. Type 8 - 1/4" thick closed cell Neoprene in sheets cut to fit penetrations, as required.

3.4 BASE TYPES: BASE TYPES AND REQUIRED DEFLECTIONS ARE SPECIFIED UNDER "SCHEDULE OF ISOLATED EQUIPMENT," PARAGRAPH 3.2, OR ARE INDICATED ON THE DRAWINGS. THE BASES SHALL COMPLY WITH THE FOLLOWING DESCRIPTIONS FOR EACH TYPE REQUIRED ON THE PROJECT.

A. Type B-1 - A structural steel fan and motor base with motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically shall be sized to limit deflection of the beam on the drive side to 0.05" due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.

B. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height-saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

PART 4 - EXECUTION

4.1 GENERAL INSTALLATION REQUIREMENTS:

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for 1-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2-inch clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

D. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, to be mounted on the scheduled vibration isolator type to prevent the transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface

from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. Refer to Section 23 05 16 – Expansion Compensation for piping connections to pumps.

4. After the piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. The isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length which will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load.

E. Piping:

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights, and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional 1/2" deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

F. Resilient Sleeves:

1. Resilient sleeves shall be provided at all points where equipment room walls, floors, or ceilings are penetrated by ducts, piping, or refrigerant line, etc.

G. Fans and Air Handling Units:

1. Such units shall have electrical flexible connections not less than 36" long and the flexible duct connections with a free length of not less than 8".

4.2 SCHEDULE OF ISOLATED EQUIPMENT:

A. Tabulated below is a schedule of equipment on this project requiring vibration isolation and base isolators of the types listed above. Any equipment, system, construction or condition that may be altered, added, or changed; or that is not specifically considered herein or on the plans shall be treated in a manner that is set out for similar equipment system or construction in order to comply with the above requirements heretofore cited.

[EXAMPLE ONLY - Edit for specific project]

Equipment	Isolator Equipment Type	Isolator Deflection	Base Isolator Type
Supply Fans:			
AC/D-1, 3, 5	1	2”	-
AC/D-2, 4	1	3”	B-2
Exhaust Fans:			
EF/D-1,2,3,4,5,6,7,8,9	1	2”	B-2
EF/D-suspended 10 thru 17	6	2”	B-1
Piping	5	1”	-
All piping and duct floor penetrations in equipment room	8	-	-
Pumps	3		B-2

END OF SECTION 23 05 48

SECTION 23 05 53 – PIPING AND EQUIPMENT IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

A. Perform all Work required to provide and install Owner's equipment tags, fire damper tags, valve tags, stencils, and pipe markers indicated by the Contract Documents with supplementary items necessary for proper installation.

B. Contractor shall make it possible for Owner's operations and maintenance personnel to readily identify the various pieces of equipment, valves, piping, ductwork, fire dampers etc., by marking them in accordance with this Specification.

C. Clearly mark all items of equipment, including but not limited to, fans, pumps, fire dampers, and valves using equipment tags as specified in this Section. The tagged item of equipment shall correspond to the same number as shown on the Drawings and as listed in the Equipment Matrix.

1.3 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. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS

A. Product Data:

1. Provide manufacturer's catalog literature for each product.

B. Record Documents:

1. Submit Equipment Matrix with Valve and Fire Damper schedules completed

C. Operation and Maintenance Data:

1. Manufacturer's Installation Instructions: Indicate special procedures and installation.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) [] square.

B. Chart: Typewritten letter size list in anodized aluminum frame.

2.3 PIPE MARKERS

A. Manufacturers:

B. Color: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.4 CEILING TACKS

2.5 GENERAL:

A. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings. For example, pumps will be identified as 3A, 3B, 3C, etc.; exhaust fans will be E-1, E-2, etc.; supply fans will be S-1, S-2, etc.

2.6 MECHANICAL:

A. All items of mechanical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed Gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

Pumps	Exhaust Fans
Terminal Units	Air Handler
Condensing Units	VFD
Unit Heater	Chilled Water Pumps
Air Conditioning Control	Booster Pumps
Panels and Switches	Air Cooled Chiller

2.7 PIPING: PIPE MARKERS AND ARROW MARKERS ALSO SHALL BE PROVIDED ON BUT NOT LIMITED TO THE PIPING OF THE FOLLOWING SYSTEMS:

Primary Chilled Water Supply		
Primary Chilled Water Return		

2.8 VALVE TAGS:

A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10' and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8" thick brass discs, 1 1/2" in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

B. Valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2" wide by 1 1/2" high with these color codlings: Red = normally closed; Green = normally open; Blue = open in winter, closed in summer; and Yellow = closed in winter, open in summer. Tags should be engraved on both sides.

C. In addition, pipe runs throughout the building including those above lift out ceilings, under floor, and those exposed to view when access doors or access panels are opened shall be identified by means of Pipe Markers. Concealed areas, for purposes of this identification section, are those areas which cannot be seen except by demolition of the building elements. In addition to the pipe markers, arrow markers shall be used to indicate direction of flow. The following specific instructions shall apply to the application of these markers:

D. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one header, it is necessary to mark only the header.

E. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.

F. Provide a double ended arrow marker when flow can be in either or both directions.

G. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.

H. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.

I. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.

J. Use snap-on type identification for all piping systems, 3/4" thru 6". For piping systems larger than 6", use strap on markers.

K. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems." Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

L. Locate markers to be visible from floor.

2.9 SPECIALS:

A. Refer to special requirements noted in the various sections hereinafter bound.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 9 for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Division 9.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with [plastic nameplates.] Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify thermostats relating to terminal boxes or valves with nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units and radiator valves with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Provide ceiling tacks to locate valves, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 23 05 53

SECTION 23 05 93 – TESTING, ADJUSTING AND BALANCING SERVICES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS CONTAIN INFORMATION REQUIRED TO FULFILL THE REQUIREMENTS OF THIS SECTION:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 06 20 – Hydronic Specialties

C. 23 09 23 – Direct Digital Controls

D. 23 20 00 – HVAC Pumps

E. 23 29 23 – Variable Frequency Drives

F. 23 31 00 – Ductwork

G. 23 33 00 – Ductwork Accessories

H. 23 34 16 - Fans

I. 23 36 00 – Air Terminal Units (VAV)

J. 23 37 00 – Air Inlets and Outlets

K. 23 57 00 – Heat Exchangers

L. 23 73 23 – Air Handling Units

M. 23 82 19 – Terminal Heat Transfer Units

1.2 SUMMARY

A. TESTING, ADJUSTING AND BALANCING (TAB) OF THE AIR CONDITIONING SYSTEMS AND RELATED ANCILLARY EQUIPMENT WILL BE PERFORMED BY AN IMPARTIAL, TECHNICALLY QUALIFIED TAB FIRM SELECTED AND EMPLOYED BY THE OWNER, SEPARATE AND APART FROM THE CONSTRUCTION CONTRACT.

B. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.

1.3 QUALIFICATIONS

A. The Firm shall be one which is organized to provide professional services of this specified type in the State of Texas and as a minimum shall have one (1) professional engineer licensed in the State of Texas, with current registration, to perform such professional services. This engineer shall be personally responsible for developing the job site data as required in the test procedures outlined in these Specifications.

B. The Firm shall have operated a minimum of five (5) years under its current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.

C. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted,

or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.

D. All personnel used on the job site shall be either professional engineers or certified TAB engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.

E. The TAB firm shall submit biographical data on the supervising Professional Engineer, the individual proposed who will directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field.

1.4 REFERENCES

A. AABC - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Seventh Edition.

B. ASHRAE - 2015 HVAC Applications Chapter 34: Testing, Adjusting and Balancing.

C. ANSI/ASHRAE Standard 111-2008 - Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.5 DOCUMENTS

A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, addenda and the following:

1. One complete set of Drawings less the structural sheets.

2. One set of mechanical floor plans of the conditioned spaces. These Drawings shall be blue or black on light background reproductions to facilitate marking.

B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.06 through 1.10 of this Specification will be available through the Construction Inspector.

1.6 RESPONSIBILITIES OF THE TAB FIRM

A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, water flow and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC Standard, Seventh Edition.

B. Liaison and Early Inspection:

1. The TAB firm personnel on the job shall act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:

a. During the design for Design Development (DD) and for two (2) Construction Document (CD) design stage submittals, at minimum, and before the documents are

finalized, review the mechanical drawings and specifications for balance-ability and provide commentary.

b. During construction, at a minimum review HVAC submittals such as: Hydronic Specialties, Direct Digital Controls, HVAC Pumps, Steam and Condensate Piping Specialties, Ductwork, Ductwork Accessories, Fans, VAV and Fan Powered Boxes, Air Inlets and Outlets, Heat Exchangers, Air Handling Units, Terminal Heat Transfer Units, etc., that pertain to balance-ability and commissioning work. The TAB Consultant shall participate as a member of the Commissioning Team.

c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, ductwork, temperature controls mechanical equipment and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Written commentary will be provided to the Resident Construction Manager (RCM) or Construction Inspector (CI) of each observation.

d. Test and inspect one (1) 8" single duct terminal box for performance capability and leakage as described in Section 23 36 00 or 23 36 10. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks (maximum) from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Agency.

e. Test and inspect one (1) 8" dual duct box for performance capability and leakage as described in Section 23 36 00. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks (maximum) from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received by the TAB agency.

f. Test 10% of the single and dual duct boxes for casing and damper leakage when the shipment arrives at the project site. All testing (except for the initial boxes) shall be performed on site. Boxes requiring re-testing will be charged to the Contractor at the unit price provided to the Owner.

g. Testing of Air Handling Units (AHU): the TAB Consultant shall witness AHU casing deflection test at the AHU factory and AHU casing leakage testing in the field at the project site.

h. Test one (1) lab configuration including fume hood with air valve, general exhaust air with air valve and supply air with air valve for performance capability through a full range of inlet pressures. The tracking capability of the exhaust air versus the supply air will be with the submitted hood sash fully open and as the sash is closed in 2" increments until fully closed. Track the three (3) valves' response time in relation to sash movement and the lab differential.

2. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the RCM and Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical

Contractor. The written document need not be formal, but must be clear, complete and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.7 FINAL AIR BALANCE

A. General: When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The supply, return, outside and exhaust air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices or the damper-in-duct tap to air device. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:

1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.

2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.

3. Ampere Readings: Measure and record full load amperes for motors.

4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured for this report at the furthest air device or terminal unit from the air handler supplying that device and recorded. Static pressure readings shall also be provided for systems which do not perform as designed.

5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.

6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).

7. Zone Air Flow: Adjust each zone VAV Terminal Box serving an AHU, each HVAC terminal unit and AHU for design CFM.

8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.

9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Provide a description of locations of these traverse test stations on the sheet containing the data.

10. Maximum and minimum air flow on terminal boxes.

1.8 FINAL CHILLED AND HEATING HOT WATER BALANCE

A. General: When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each chilled and hot water system. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:

1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow, +5%. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve (Note: If discharge valves on the pumps are used for balancing record the head being restricted by the valves).

2. Temperature Readings: Read and record entering and leaving water temperature at each water coil, converter and heat exchanger. Adjust as necessary to secure design and conditions. Provide final readings at all thermometer well locations.

3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

4. Ampere Readings: Reading and record full load amperes for each pump motor.

1.9 SOUND VIBRATION AND ALIGNMENT

A. Sound: Read and record sound levels at up to 15 locations in the building designated by the Engineer. All measurements shall be made using an Octave Band Analyzer. All tests shall be conducted when the building is quiet in the presence of the Engineer, if he so desires.

B. Vibration: Read and record vibration for all water circulating pumps, air handling units, and fans which have motors larger than 10 HP. Include equipment vibration, bearing housing vibration, foundation vibration, building structure vibration, and other tests as directed by the Engineer. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms. Maximum vibration at any point listed above, or specified, shall not exceed deflection allowed per Section 23 34 16 for fans and deflection allowed per Section 23 20 00 for pumps unless otherwise specified. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.10 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. In the process of performing the TAB work, the TAB Agency shall:

1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.

2. Verify that all control devices are properly connected.

3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.

4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).

5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes terminal boxes and fire/smoke dampers.

6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.

7. Observe the calibration of all controllers.

8. Verify the proper application of all normally opened and normally closed valves.

9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.

10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media Should an adjustment of the installation be required, the TAB Consultant will provide a recommendation to the RCM and/or CI to coordinate with the Controls subcontractor to resolve as required for proper operation.

11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.

12. Verify that all controller setpoints meet the design control sequence..

13. Check all dampers for free travel.

14. Verify the operation of all interlock systems.

15. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

1.11 STAIRWELL PRESSURIZATION SYSTEMS

A. With all doors closed, measure the door pull to determine that the opening force required is below 30 pounds force.

B. With all doors closed, measure the pressure differential across each door to verify the pressure differentials at each floor.

C. Measure the air flow in the stairwell with the maximum number of doors fully open by pitot tube traverse, if traverse locations are available. If traverse locations are not available, measure air flow at each outlet.

D. Verify with smoke that the smoke detector in the stair pressurization fan inlet shuts the fan down.

E. Verify stairwell pressurization system complies with IBC.

1.12 REPORTS

A. The activities described in this section shall culminate in a report to be provided on three (3) CDs and one (1) individually bound printed copy to the RCM. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or Engineers of the firm.

C. TAB personnel shall submit copies of preliminary field measurements on data sheets tabulated each day to the Commissioning Authority.

D. Submit reports on forms from the AABC manual approved by the Owner & Engineer which will include the following information as a minimum:

1. Title Page
    a. Company Name
    b. Company Address
    c. Company telephone number
    d. Project name
    e. Project location
    f. Project Manager
    g. Project Engineer
    h. Project Contractor
    i. UT System Project Identification Number
2. Instrument List
    a. Instrument
    b. Manufacturer
    c. Model
    d. Serial Number
    e. Range
    f. Calibration date
    g. What test instrument was used for
3. Fan Data (Supply and Exhaust)
    a. Identification/location
    b. Manufacturer
    c. Model
    d. Airflow, specified and actual
    e. Total static pressure (total external), specified and actual
    f. Inlet pressure
    g. Discharge pressure
    h. Fan RPM
4. Return Air/Outside Air Data (If fans are used, same data as for 3 above)
    a. Identification/location
    b. Design return air flow
    c. Actual return air flow
    d. Design outside air flow
    e. Return air temperature
    f. Outside air temperature
    g. Required mixed air temperature
    h. Actual mixed air temperature
5. Electric Motors

a. Manufacturer
b. HP/BHP
c. Phase, voltage, amperage, nameplate, actual
d. RPM
e. Service factor
f. Starter size, heater elements, rating

6. V-Belt Drive
   a) Identification/location
   b) Required driven RPM
   c) Driven sheave, diameter and RPM
   d) Belt, size and quantity
   e) Motor sheave, diameter and RPM
   f) Center-to-center distance, maximum, minimum and actual

7. Duct Traverse
   a) System zone/branch/location
   b) Duct size
   c) Area
   d) Design velocity
   e) Design air flow
   f) Test velocity
   g) Test air flow
   h) Duct static pressure
   i) Air temperature
   j) Air correction factor

8. Air Monitoring Station Data
   a) Identification/location
   b) System
   c) Size
   d) Area
   e) Design velocity
   f) Design air flow
   g) Test velocity
   h) Test air flow

9. Air Distribution Test Sheet
   a) Air terminal mark number
   b) Room number/location
   c) Terminal type
   d) Terminal size
   e) Area factor
   f) Design velocity
   g) Design air flow
   h) Test (final) velocity
   i) Test (final) air flow

10. Pump Data
    a) Identification/number
    b) Manufacturer
    c) Size/model
    d) Impeller
    e) Service
    f) Design flow rate, pressure drop, BHP
    g) Actual flow rate, pressure drop, BHP

h) Discharge pressure
i) Suction pressure
j) Total operating head pressure
k) Shut off, discharge and suction pressure
l) Shut off, total head pressure
m) Pressure differential settings

11. Cooling Coil Data
a) Identification/number
b) Location
c) Service
e) Manufacturer
f) Entering air DB temperature, design and actual
g) Entering air WB temperature, design and actual
h) Leaving air DB temperature, design and actual
i) Leaving air WB temperature, design and actual
j) Water pressure flow, design and actual
k) Water pressure drop, design and actual
l) Entering water temperature, design and actual
m) Leaving water temperature, design and actual
n. Air pressure drop, design and actual

12. Heating Coil Data
a) Identification/number
b) Location
c) Service
d) Manufacturer
e) Air flow, design and actual
j) Entering air temperature, design and actual
k) Leaving air temperature, design and actual
l) Air pressure drop, design and actual

13. Sound Level Report
a) Location (Location established by the design engineer)
b) NC curve for eight (8) bands - equipment off
c) NC curve for eight (8) bands - equipment on

14. Vibration Test on equipment having 10 HP motors or above
a) Location of points:
1) Fan bearing, drive end
2) Fan bearing, opposite end
3) Motor bearing, center (if applicable)
4) Motor bearing, drive end
5) Motor bearing, opposite end
6) Casing (bottom or top)
7) Casing (side)
8) Duct after flexible connection (discharge)
9) Duct after flexible connection (suction)
b) Test readings:
1) Horizontal, velocity and displacement
2) Vertical, velocity and displacement
3) Axial, velocity and displacement
c) Normally acceptable readings, velocity and acceleration
d) Unusual conditions at time of test
e) Vibration source (if non-complying)

15. Control verification indicating date performed and any abnormalities identified.
    a) Point Location/Description
    b) EMS Readout (Setpoint and Actual)
    c) Interlocks
    d) Safeties
        1) VFD Normal Operation
        2) VFD Bypass Operation
    e) Alarms
    f) Sequences of Operation

END OF SECTION 23 05 93

SECTION 23 05 94 – SYSTEM PREPARATION FOR TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

D. Section 23 05 93 – Testing, Adjusting and Balancing

1.2 SUMMARY

A. Perform all work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:

1. Responsibilities of project contractor

2. Preparation for balancing of air systems

3. Preparation for balancing of hydronic and steam systems

B. The scope of the TAB work as defined in Section 23 05 93 is indicated in order that the Contractor will be advised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB. The TAB firm will not have a contractual relationship with any Contractor referred to herein, but will be responsible to the Construction Inspector and the Owner for the satisfactory execution of the TAB work. The Contractor in his original bid shall allow for the costs required to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.3 RELATED SECTIONS

A. Section 23 05 48 - Vibration Isolation

B. Section 23 05 93 – System Testing, Adjusting and Balancing

C. Section 23 06 20.13 - Hydronic Specialties

D. Section 23 09 23 - Direct Digital Control Systems

E. Section 23 20 00 - HVAC Pumps

F. Section 23 31 00 - Ductwork

G. Section 23 33 00 - Ductwork Accessories

H. Section 23 34 16 - Fans

I. Section 23 36 00 - Air Terminal Units (VAV)

J. Section 23 37 00 - Air Inlets and Outlets

K. Section 23 38 16 – Fume Hoods

L. Section 23 73 23 - Air Handling Units

M. Section 23 82 16 - Air Coils

N. Section 23 82 19 - Terminal Heat Transfer Units

1.4 SCOPE OF WORK

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed directly by the Owner, separate and apart from the Construction Contract. However, the preparation for and corrections necessary for the Testing, Adjusting and Balancing of these systems, as described herein, are the responsibility of the Contractor.

B. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc. required for correct balance as advised by the TAB firm, at no additional cost to the Owner.

C. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.

D. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate said systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be subject to the approval of the Construction Inspector.

E. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The contractor shall allow adequate time for the testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

F. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Construction Inspector shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.5 RESPONSIBILITIES OF THE PROJECT CONTRACTOR:

A. The Contractor shall:

1. Have the building and air conditioning systems in complete operational readiness for TAB work to begin.

2. The contractor shall allow sufficient time for the TAB firm to perform his contracted work within the construction schedule. The contractor shall complete his work by systems or floors whichever is the most efficient for scheduling. After awarding of the contract and the contractor has developed a construction schedule, a TAB coordination meeting shall be

held at the RCM's office with the TAB agency, the general contractor and his primary subcontractors (i.e. mechanical, electrical, building automation etc.) to develop a testing schedule for the project. The contractor shall submit copies of the proposed schedule two (2) weeks prior to this meeting to the RCM and TAB Agency.

a. Note: The hot water and chilled water systems must be 100% complete to balance. The air systems are pressure independent and can be balanced by floors, risers, systems, etc., but once the total system is complete the total flows and system tracking will require finalization. Lab certification will be performed when the building is 100% operational and balanced.

3. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.

4. Be responsible for any added costs to the Owner resulting from his failure to have the building and air conditioning systems ready for TAB when scheduled, or from his failure to correct deficiencies promptly.

B. Complete operational readiness of the building requires that construction status of the building shall permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.

C. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:

1. Air Distribution Systems:

a. Verify installation for conformity to design. All supply, return and exhaust ducts terminated and pressure tested for leakage as required by the Specification.

b. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation. All manual volume dampers shall be set in the full open position prior to starting TAB.

c. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices installed.

d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be blanked and/or sealed to eliminate excessive bypass or leakage of air.

e. All fans (supply, return and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating; record motor amperage and voltage on each phase at start-up and running, and verify they do not exceed nameplate ratings.

f. All single and/or double duct variable and constant volume terminal units ("mixing boxes") shall be installed and functional (i.e. controls functioning).

2. Water Circulating Systems:

a. Check and verify pump alignment and rotation.

b. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and

checked for proper operation, remove and clean all strainers. The Contractor shall repeat the operation until circulating water is clean.

c. Record each pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.

d. Verify that the electrical heater elements are of the proper size and rating.

e. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.

f. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

3. Automatic Controls:

a. The Contractor shall schedule a meeting with the Engineer, Control Contractor, TAB firm and Owner's representative for a pre-submittal review to establish that their interpretations of the sequences of operation are correct.

b. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, dampers sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.

c. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB firm and Control Contractor.

d. The Automatic Temperature Control Contractor and/or Energy Management System Contractor shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB agency that the Automatic Temperature Controls and Energy Management System are operational. The Automatic Temperature Contractor and/or Energy Management System Contractor shall provide technical support (technicians and necessary computers) to the TAB agency for a complete check of these systems.

4. Tabulated Data: The motor amperages, voltages shall be recorded showing "actual" and "nameplate" voltage and amperage and submitted and actual RPM. This applies to each piece of electrically driven air conditioning equipment in the system including supply and exhaust fans, fans of fractional horsepower, pumps, etc.

D. Notification of System Readiness:

1. After completion of the work in Paragraph 1.5A through C above, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing. The Contractor shall include a copy of the tabulated data of Paragraph 1.5 C.4 above.

2. The Owner will, in turn, notify the TAB firm of the readiness for balancing and forward copies of the Contractor's certification and the tabulated voltages and currents.

3. Should the TAB firm be notified as described above, and the TAB work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by duly appointed representative of the Owner, Architect, TAB firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriated parties by the Project Contractor.

1.6 RESPONSIBILITIES OF THE TAB FIRM

A. Refer to Section 23 05 93 entitled "System Testing, Adjusting and Balancing."

END OF SECTION 23 09 23.A

SECTION 23 06 20 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

D. Section 23 20 00.A – Piping, Valves, and Fittings

1.2 WORK INCLUDED

A. Expansion Tanks

B. Automatic Air Vents

C. Air Separators

D. Strainers

E. Gauges and Gauge Connections

F. Thermometer and Thermometer Wells

G. Pump Suction Fittings

H. Water Relief Valves

I. Water Flow Measuring and Balancing System

J. Chilled Water and Steam Integrating Meters

1.3 RELATED WORK

A. Section 23 21 00 - Hydronic Piping

1.4 REFERENCES

A. ANSI/ASME - Boilers and Pressure Vessels Code (BPVC)

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section VIII for manufacture of tanks.

1.6 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.7 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Include component sizes, rough in requirements, service sizes, and finishes. Include product description, model number and dimensions.

D. Submit inspection certificates for pressure vessels.

E. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 EXPANSION TANKS

A. Construction: Closed, welded steel, tested and stamped in accordance with Section VIII D of ANSI/ASME BPVC; 125 psi rating; cleaned, prime coated, and supplied with steel support saddles; with tappings for installation of accessories.

B. Quick Connect Air Inlet: Schrader type valve, manual air vent, tank drain, and pressure relief valve.

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved bypass.

D. Chilled Water System: Set expansion tank pressure relief valve at 125 psi maximum and pressure reducing valve at 100 psi.

E. Refer to schedule on plans for capacities and dimensions.

2.2 AUTOMATIC AIR VENTS

A. Provide an automatic air vent,at the highest points of the chilled water and hot water systems and on the chilled and hot water coils and elsewhere as shown on the Drawings, Armstrong No. 21AR or approved equal with a pressure rating of 250 psig. Provide shut-off valve to facilitate maintenance of air vent. Locate all air vents and their discharge lines in accessible locations, preferably clustered.

2.3 AIR SEPARATORS

A. Dip Tube Fitting: For 125 psig operating pressure; to prevent free air collected in boiler from rising into system.

B. In-line Air Separators: Cast iron for sizes 1-1/2 inches and smaller, or steel for sizes 2 inches and larger; tested and stamped in accordance with Section VIII D of ANSI/ASME BPVC; for 125 psig operating pressure.

C. Air Elimination Valve: Bronze, float operated, for 125 psig operating pressure.

D. Combination Air Separators/Strainers: Steel, tested and stamped in accordance with Section VIII D of ANSI/ASME BPVC, for 125 psig operating pressure, with galvanized steel integral strainer with 3/16 inch perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 STRAINERS

A. Each control valve for chilled water and heating water, and each pressure reducing valve assembly regardless of its size shall be preceded by a sediment strainer. The arrangement of these sediment strainers shall be such that the screens may be removed for cleaning with ease through a gasketed plug. Monel or stainless steel shall be used to fabricate the noncollapsible lapped screens, which shall contain no soldered joints.

B. Sediment strainers shall be placed in piping systems wherever shown on the Drawings and at such other points as may be required for the removal of foreign material from the piping systems.

C. In piping two inches (2") and smaller, strainers shall be Mueller 11M, Watts 77S, or approved equal wye-strainer. Strainers 2-1/2" and larger shall be Mueller 781 series, Watts 77F or approved equal wye-strainer.

D. Strainers, 2" and smaller shall have a cast steel body, screwed ends, No. 20 mesh strainer, and screwed cap with bronze blow off valve (size to be determined by standard tap size in cap). Strainers, 2 1/2" and larger shall have a cast steel body, dielectric isolating type flanged ends where installed in copper lines, 0.125” perforated Monel or stainless steel strainer, and flanged cap with bronze ball blow off valve (size of blow off valve shall be determined by standard tap size in cap). All strainers 6" and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

E. Full sized blow off valves shall be installed on all strainers in steam, condensate, chilled and hot water lines and a drain shall be installed from each valve to the nearest floor drain.

2.5 GAUGES AND GAUGE CONNECTIONS

A. Furnish and install Ashcroft No. 1279A Duragauges on both suction and discharge sides of pumps, complete with Ashcroft No. 1095 lever handle shut-off cocks, and Ashcroft No. 1106B pulsation piston type dampeners, or approved equal. Porous type will not be accepted. Gauges shall have stainless steel movement and be accurate to 0.5%. Gauges shall be in PSI. Gauges shall have back connection when used on a panel; otherwise they shall have bottom connections. The graduation of the dials and the arrangement of the mechanisms shall conform to the pressure range details shown on the Drawings.

B. Combination pressure or vacuum gauges shall be Ashcroft Duragauges Number 1279A, with an appropriate vacuum range, or approved equal. The accessories for these gauges shall conform to those prescribed for pressure gauges.

C. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these Specifications, gauge connections complete with Ashcroft No. 1095 lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

2.6 THERMOMETER AND THERMOMETER WELLS

A. Furnish and install thermometers of not less than 9" scale complete with brass separable sockets with extension neck to allow for insulation of piping. These thermometers shall be red reading tube type with mercury in one piece glass tubes extending from top of scale to sensor, and shall be located so that they may be easily read. Field adjustable angle thermometers are acceptable. Thermometers shall in all cases be installed upright or at the proper angle to be read while standing on the floor. The wells for thermometers shall be located in vertical pipes where possible and when necessary in horizontal pipes they shall be installed in the side and not on the top of the pipe. They shall be Weksler Industrial Thermometers, or approved equal, with range of 0 to 100 degrees F. for chilled water, and 0 to 220 degrees F for hot water.

B. Thermometer wells and thermometers shall be located where noted on the accompanying Drawings and where called for in other sections of the Specifications. Thermometer test wells only shall be installed in a vertical position in horizontal lines and at 45 degrees, in vertical lines to hold a fluid in the well.

C. Thermometer test wells shall be 3/4" Weksler Thermal Wells, brass with stem of minimum length to extend beyond the mid-diameter of the pipe, 2-1/2" extension neck, and brass screw plug. Wells shall be suitable for use of industrial type thermometers.

D. Indicating thermometers shall be placed in lines wherever shown on the Drawings. These thermometers shall be Weksler Industrial Thermometers having stainless steel separable sockets and scales of the range shown on the Drawings.

E. Provide thermometer and thermowell assemblies, as described above, with one assembly each for the chilled water supply and return main pipes. Install the assemblies in close proximity to the RTDs that are provided for the chilled water BTU meter.

2.7 WATER RELIEF VALVES

A. The pressure relief valves installed for the protection of the water circulating circuits shall be Bell & Gossett 790 single seated diaphragm and spring type valves with screwed connections or approved equal. They shall be 3/4" size of bronze construction with EPDM diaphram and seat.

2.8 CHILLED [AND HOT] WATER [AND STEAM CONDENSATE] FLOW MEASURING AND BALANCING SYSTEM (SUB-METERING)

A. Furnish and install complete Onicron System 10 BTU metering system.

B. This shall be a coordinated system. Flow Stations shall be Onicron F-3000 series or approved equal inline electromagnetic flow meters. Flow Station shall be installed in a straight run of pipe in accordance with manufacturer's requirements for the specific installation in order to maintain rated accuracy.

C. Unit shall accommodate the following fluid operating ranges:

Temperature: 36° to 250° F.
Pressure: 0 to 150 psi.

2.9 BUILDING MAIN CHILLED WATER INTEGRATING METERS:

A. Furnish and install complete Onicron System 10 BTU metering system.

B. This shall be a coordinated system. Flow Stations shall be Onicron F-3000 series inline electromagnetic flow meters. Flow Station shall be installed in a straight run of pipe in accordance to manufacturer's guidance for the specific installation in order to maintain rated accuracy. Flow stations shall be of steel construction, welded in place.

C. Each flow station shall consist of a flow sensor with laminated or metal identification tag on chain giving pipe size, meter series, and station identification.

D. Wall mounted meter shall be complete with adequate lengths of cables to attached sensors, and installation and operating instructions. Meter shall operate on 115 VAC. Meter shall be backlit LCD and shall indicate:

1. Instantaneous flow rate in GPM, and total flow in gallons.
2. Meter shall have dual outputs for each of the displayed values. Out puts shall be 4-20 mA and TTL pulse rate, each proportional to display values, compatible with building EMS.
3. Meter shall have positive zero flow indication.

E. Unit shall accommodate the following fluid operating ranges:

Temperature: 36° to 250° F.
Pressure: 0 to 150 psi.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Support tanks inside building from building structure in accordance with manufacturer's instructions.

C. Provide manual air vents at system high points and as indicated.

D. Provide manual air vents at entrance to all heating hot water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.

E. For automatic air vents in ceiling spaces or other concealed locations, extend vent tubing to nearest drain.

F. Provide air separator on suction side of system circulation pump and connect to expansion tank.

G. Provide valved drain and hose connection on strainer blow down connection.

H. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

I. Support pump fittings with floor mounted pipe and flange supports.

J. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

L. Pipe relief valve outlet to nearest floor drain.

M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 23 06 20.13

SECTION 23 07 13 – DUCTWORK INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Ductwork insulation

B. Insulation jackets

1.3 RELATED SECTIONS

A. Section 09 91 00 - Painting: Painting insulation jackets

B. Section 23 31 00 - Ductwork: Duct liner

C. Section 23 33 00 - Ductwork Accessories: Duct liner

1.4 REFERENCES

A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate

B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation

D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation

E. ASTM E84 - Surface Burning Characteristics of Building Materials

F. ASTM E96 - Water Vapor Transmission of Materials

G. NFPA 255 - Surface Burning Characteristics of Building Materials

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

I. UL 723 - Surface Burning Characteristics of Building Materials

J. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

1.7 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. In no instance shall ductwork insulation be stored outdoors or where subject to moisture damage.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 INSULATION A:

A. Three pound per cubic foot minimum density glass fiber semi-rigid board insulation with fiber perpendicular to the surface and with factory applied white foil reinforced vapor barrier jacket (ASJ). Insulation shall be equal to E.O. Woods Company "Rigid-Wrap".

B. The insulation shall be secured to the ducts with mechanical fasteners; "Stick-clips", Graham Pins or Speed Clips, and shall be spaced approximately 12" on center on bottom of duct and where required elsewhere to hold insulation securely against the duct per the Insulation Manufacturer recommendations. Stick pins welded to ductwork are not acceptable.

1. Insulation on the bottom of duct and on vertical sections shall be coated with an adhesive and pushed firmly against the ductwork as well as being secured with mechanical fasteners. Adhesives shall be approved by the insulation manufacturer for use with the insulation and shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. After insulation is in place, all joints and seams shall be sealed with Foster 30-90 white vapor barrier mastic (water based) applied over a 3" wide strip of Duramesh Glass Fabric. All protrusions through the vapor barrier shall be thoroughly sealed.

D. On ducts that are reinforced with standing seams or angle iron stiffeners 1" and over in height, the Contractor shall apply a strip of fiberglass board 1" thick by 6" wide, sealing same to the other insulation with mastic.

2.2 INSULATION B:

A. Three pound per cubic foot minimum density glass fiber rigid board insulation with factory applied white foil reinforced All Service Jacket (ASJ).

B. Insulation B shall be applied as specified for Insulation A.

C. Contractor at his option may substitute Insulation A where Insulation B is called for.

2.3 INSULATION C :

A. Blanket insulation with a thermal conductivity (K) of 0.27 or less similar in construction to Owens-Corning Fiberglass Series one pound per cubic foot minimum density with foil reinforced Kraft (FRK) vapor barrier facing. Insulation shall be applied flat on the ductwork with all circumferential joints butted. longitudinal joints overlapped a minimum of 2" and per manufacturer's recommendations. Adhere insulation to metal with 4" strips of insulation bonding adhesive at 8" on center. On circumferential and longitudinal joints, the 2" flange of the facing shall be secured using 9/16" flare door staples applied 6" on center and taped with 4" wide fiberglass tape embedded in Foster 30-90 white vapor barrier Emulsion and covered with Foster 30-90 white vapor barrier Emulsion until the tape is completely covered. All pin penetrations or punctures in facing shall also be taped.

2.4 PROTECTIVE JACKETING

A. Jacketing and fitting covers shall be 0.016" aluminum smooth as manufactured by Premetco or Childers. The jacket shall be pre-cut, pre-rolled and lapped a minimum of two inches (2") in all directions to shed water. The metal shall be secured at each joint with a minimum of one each ¾" wide 0.020" aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016" aluminum or stainless steel with a smooth finish.

2.5 SCOPE OF DUCT INSULATION

A. All ductwork in the building and in the crawl spaces except toilet exhaust and fume hood exhaust ducts shall be insulated externally unless specifically excluded. Only sound attenuated return ducting may be insulated internally, if specifically designated as such. Refer to section 23 33 00 for duct liner specifications.

B. Where ducts are lined internally, (see Drawings for Scope) no exterior insulation will be required, except where specifically stated otherwise. Where internal and external insulation join, they shall lap at least 24 inches.

C. Low pressure supply duct taps to ceiling diffusers shall be externally insulated including top of ceiling diffuser with 2" Insulation C.

D. Flexible round ducts are specified in Section 23 31 00 as factory insulated.

E. All kitchen hood exhaust ductwork connected to both inlet and discharge sides of Fans shall be insulated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Insulated ductwork conveying air below ambient temperature:

1. Finish with tape and vapor barrier jacket.

2. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

3. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:

1. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. For ductwork exposed in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

E. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

F. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

G. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

H. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the duct

has been successfully leak tested. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

I. Vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

J. Extreme care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and all mixing boxes) ductwork to insure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

K. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

L. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer's recommendations.

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 DUCT INSULATION SCHEDULE:

Duct Type	Duct Location	Insulation Type	Insulation Thickness (inches)	R Value	Jacketing
Supply Air (Hot or Cold) Round and Oval	Conditioned and plenum	A	2	6	ASJ
Supply (Hot or Cold) Air Rectangular	Conditioned and plenum	B	2	6	ASJ
Rectangular Return	Conditioned and plenum	None	0	0	
Rectangular Relief	Conditioned and plenum	B	2	6 (Note 1)	ASJ
Outside Air	Conditioned and plenum	B	2	6	ASJ

1. Relief air duct is insulated from the point where the duct exits the building 6' in the direction counter to airflow.

END OF SECTION 23 07 13

SECTION 23 07 16 – EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Equipment insulation

B. Covering

C. Breaching insulation

1.3 RELATED SECTIONS

A. Section 09 91 00 - Painting: Painting insulation covering

1.4 REFERENCES

A. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B. ASTM C177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded- Hot-Plate Apparatus

C. ASTM C195 – Standard Specification for Mineral Fiber Thermal Insulation Cement

D. ASTM C335 – Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

E. ASTM C449 – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

F. ASTM C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

G. ASTM C533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

H. ASTM C534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

I. ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation

J. ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

K. ASTM C612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation

L. ASTM C921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

M. ASTM D1056 – Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber

N. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

O. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials

P. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

Q. UL 723 – Test for Surface Burning Characteristics of Building Materials

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide product description, list of materials and thickness for equipment scheduled.

C. Samples: Submit two samples of any representative size illustrating each insulation type.

D. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with UL 723/ASTM E84.

1.7 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise noted, equipment shall be insulated with same insulation type and thickness as is used for piping which equipment serves.

2.2 TYPE A: HIGH TEMPERATURE FIBERGLASS

A. ESLIN EG-SCUI or equal glass fiber insulation piping insulation with a “K” factor of 0.30 BTU-In/Hr.-degree F at 200°F and 0.48 BTU-In/Hr.-degree F at 600°.

1. Rated maximum service temperature of 1200°F (650°C).
2. Maximum density of 12.5 lbs/ft³
3. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.
4. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
5. Certified to meet the requirements of ASTM C795 for use over stainless steel.
6. Rated as noncombustible when tested in accordance with ASTM E136.
7. Insulation treated with water resistant resin on the surface and within each layer of the insulation
8. Thickness of insulation shall be sufficient to reduce the surface temperature to the maximum permitted by OSHA and other governing criteria, but in no case more than 150 degrees F.

2.3 TYPE B: FOAM GLAS

A. Foamglas One Insulation with a “K” factor of 0.29 BTU-In/Hr.-degree F at 75°F manufactured by Pittsburgh Corning Corporation and fabricated by a Pittsburgh Corning Corporation-approved fabricator. Water vapor permeability shall be 0.00 perm-in. The insulation shall comply with ASTM C 552 Type II, furnished in half sections up to 36 inches long or segments 18 inches long.

1. Rated maximum service temperature of 900°F.
2. Maximum density of 7.3 lbs/ft³
3. Compressive strength of 90 psi minimum when tested in accordance with ASTM C165.
4. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
5. Certified to meet the requirements of ASTM C795 for use over stainless steel.
6. Rated as noncombustible when tested in accordance with ASTM E136.
7. Fitting insulation shall be applied in same manner as pipe application. Refer to piping insulation specification for proper guidance.

2.4 PUMPS:

A. Each water pump shall not be insulated but the insulation of the connecting piping shall be continued up to the face of the flanges on the piping connection to the pump and any bare metal that projects over the bed plate of the pump and from which condensation might drip onto the floor.

2.5 BUILT UP AIR CONDITIONING CASINGS AND DRAIN PANS:

A. All walls and ceilings in the built up system plenums shall be lined with Micro-Aire M/F Fiberglass ductboard Type 475, 1" thick. Liner shall be applied to the ceilings and walls with quick tacking rubber base adhesive. Liner shall be additionally secured to surfaces with stick clips and washers spaced 16" on centers. Provide No. 6 mountings, ASTM-C-60T sound absorption test method.

B. Floors of built up system plenums shall be insulated externally (beneath the floor surface) with 2 inch thick Insulation A, or its equivalent (including vapor barrier protection) integrated into the architectural/structural construction, in all instances where plenums may act as drain pans or otherwise collect moisture, or where personnel access is possible. In all other plenums, floors shall be lined as hereinbefore specified for walls and ceilings.

2.6 PROTECTIVE JACKETING

A. Metal jacketing: Aluminum or stainless steel jacket, 0.016" thick, banded with ¾" aluminum banding (0.020" thick) using 3 bands per three foot (3') section of covering.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Do not insulate factory insulated equipment.

C. On exposed equipment, locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:

1. Provide vapor barrier jackets, factory applied or field applied.

2. Finish with glass cloth and vapor barrier adhesive.

3. Insulate entire system.

G. Inserts and Shields:

1. Application: Equipment 2 inches diameter or larger.

2. Shields: Galvanized steel between hangers and inserts.

3. Insert location: Between support shield and equipment and under the finish jacket.

4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Heavy density insulating material suitable for the planned temperature range.

H. Finish insulation at supports, protrusions, and interruptions.

I. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

J. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

K. Cover cellular glass and cellular foam insulation with aluminum jacket.

L. Do not insulate over any nameplate or ASME stamps. Bevel and seal insulation around such.

M. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

N. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

O. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

P. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

Q. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 15A.

R. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

S. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer’s recommendations.

END OF SECTION 23 07 16

SECTION 23 07 19 – PIPING INSULATION

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors

C. 23 05 53 -- Mechanical Identification

1.2 SECTION INCLUDES

A. Piping insulation

B. Jackets and accessories

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.

1.4 RELATED SECTIONS

A. 23 00 00 General Mechanical Requirements

1.5 REFERENCES

A. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate.

B. ASTM C177 Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

C. ASTM C195 Mineral Fiber Thermal Insulation Cement.

D. ASTM C335 Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

E. ASTM C449 Mineral Fiber Hydraulic setting Thermal

F. ASTM C518 Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

G. ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534 Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C547 Mineral Fiber Preformed Pipe Insulation.

J. ASTM C552 Cellular Glass Block and Pipe Thermal Insulation.

K. ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation.

L. ASTM C585 Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

M. ASTM C921 Properties of Jacketing Materials for Thermal Insulation.

N. ASTM D1056 Flexible Cellular Materials Sponge or Expanded Rubber.

O. ASTM D2842 Water Absorption of Rigid Cellular Plastics.

P. ASTM E84 Surface Burning Characteristics of Building Materials.

Q. ASTM E96 Water Vapor Transmission of Materials.

R. NFPA 255 Surface Burning Characteristics of Building Materials.

S. UL 723 Surface Burning Characteristics of Building Materials.

T. ASHRAE 90.1 – Energy Standard for Buildings Except Low Rise Residential Buildings

1.6 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide product description, list of materials 'k' value, 'R' value, mean temperature rating, and thickness for each service, and locations.

C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.7 QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84 89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00.

C. All piping shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.

1.8 QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years' experience specializing in the trade.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

C. All insulation materials to be asbestos free.

PART 2 - PRODUCTS

2.1 TYPE A: CALCIUM SILICATE:

A. Manville Thermo-12 or equal calcium silicate sectional piping insulation with a "K" factor of 0.40 BTU-In/Hr.-degree F at 100°F and 0.50 BTU-In/Hr.-degree F at 400°
   1. Rated maximum service temperature of 1200°F (650°C).
   2. Maximum density of 15 lbs/ft³
   3. Compressive strength of 100 psi minimum when tested in accordance with ASTM C165.
   4. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
   5. Certified to meet the requirements of ASTM C795 for use over stainless steel.
   6. Rated as noncombustible when tested in accordance with ASTM E136.
   7. Effective corrosion inhibitor is equal to or better then DI water standard when tested in accordance with ASTM C1617.
   8. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.
   9. Installation:
      a. Joints shall be sealed with aluminum snap straps provided, fastened in place with ¾" wide x .020" stainless steel bands. Fittings and valves shall be insulated with the same thickness as that applied to the adjacent pipe and shall have an outer removable covering of aluminum.
      b. Pipe insulation shall be firmly wired in place by the use of no less than six (6) loops of No. 16 annealed copper clad iron wire per three foot section of insulation. These sections shall be staggered. The ends of these loops shall be twisted together tightly and bent over and hammered into the insulation so as to leave no projection. Bands shall be .020" thick, ¾" wide, 3 bands per section of insulation. Fittings, valves, etc., shall have bands on each side.
      c. All fittings on pipe 4" and larger shall be covered with the same material as the pipe, mitered and smoothed, and securely wired to the pipe.

d. Fittings and valves for pipe smaller than 4" shall be insulated with Calcoat-127 insulating finishing cement and each application shall be in layers not thicker than ½". Each layer shall be allowed to dry before the next layer is applied.
e. All cracks and voids in this insulation shall be filled carefully with Calcoat-127 insulating finishing cement so that the resulting surface is smooth and continuous.
f. At all pipe flanges, the insulation shall be beveled in such a manner that access may be had to the bolt studs and nuts without injuring the insulation where removable covers have been specified.
g. A layer of 40 pound rosin-size paper or ¾ pound deadening felt shall be wrapped around the insulation before an 8 ounce canvas jacket is pasted in place. This canvas jacket shall be pasted onto the covered pipe valves and fittings (where insulated) in a neat and workmanlike fashion, using adhesive.
h. All flanges, valves, pressure regulating valves, strainers, and any other hot surfaces shall be covered with a built-up removable covering made of Thermo-12 Pipe Covering with a finishing coat of Calcoat-127 insulating finishing cement. This removable covering shall be banded on the valve or joint in such a fashion that it can readily be removed and replaced; it shall be of the same thickness as the insulation on the adjoining pipe.
i. Piping insulated with calcium silicate pipe insulation and finished with canvas outer jacket shall be painted in accordance with campus paint scheme.

2.2 TYPE B: FOAM GLAS

A. Foamglas One Insulation with a "K" factor of 0.29 BTU-In/Hr.-degree F at 75°F manufactured by Pittsburgh Corning Corporation and fabricated by a Pittsburgh Corning Corporation-approved fabricator. Water vapor permeability shall be 0.00 perm-in. The insulation shall comply with ASTM C 552 Type II, furnished in half sections up to 36 inches long or segments 18 inches long.
1. Rated maximum service temperature of 900°F.
2. Maximum density of 7.3 lbs/ft³
3. Compressive strength of 90 psi minimum when tested in accordance with ASTM C165.
4. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
5. Certified to meet the requirements of ASTM C795 for use over stainless steel.
6. Rated as noncombustible when tested in accordance with ASTM E136.
7. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.
8. Installation:
   a. Prior to application of any insulation, all metal surfaces shall be thoroughly cleaned. The metal shall then be primed with an asphaltic primer consisting of one (1) coat of Foster No. 60-26 Primer or Pittcote 300 Primer. Cleaning and priming specified in this paragraph is not included in requirements for "Cleaning and Painting" specified in other sections of the Specifications. Regular Foamglas or phenolic foam insulation shall be applied to the piping with butt joints staggered and all joints tightly butted and sealed with a ¼" bead of joint sealer ½" from outside edge. Hold in place with 14 gauge copper clad wire 9" o.c. After insulation has been wired in place, a 1/16" minimum thick, 3" wide band of asphaltic vapor seal mastic shall be brushed or troweled on the outside of the Foamglas or phenolic foam insulation at the approximate location of the aluminum bands. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) An aluminum jacketing 0.016" thickness equal to Gasco, Papco RPR Metals, or other precast, pre rolled Z-lock Kraft paper lined pipe covering with zee type closure and ¾" wide snap straps with permanent sealant shall then be fitted to O.D. of insulation and applied over the insulated pipe with 3" end and side caps secured with aluminum bands on 12" centers. Longitudinal joint of aluminum jacketing shall be placed with overlap directed to bottom of pipe. Any voids in the completed installation of the insulation

shall not be filled with vapor seal coating but shall be eliminated by refitting or replacing insulation.

b. Foamglas or phenolic foam insulation on flanges, valves and other fitting shall consist of prefabricated fitting covers of the same thickness as specified for adjoining pipe insulation.
c. Fitting covers shall be applied in same manner as pipe application except that 16 gauge aluminum wire may be used to secure screwed fitting covers. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Papco or RPR Metals prefabricated fitting covers of 0.016" paper coated aluminum, secured as recommended by the manufacturer.
d. The insulation thickness shall be as scheduled.
e. Fitting covers shall be built up of shaped segments of Foamglas or phenolic foam. These fitting covers shall be adhered in place using "Foster No. 30-35 water based vapor seals, then smoothly covered by a one-quarter inch (1/4") thick application of one coat white insulating cement. All this piping and fittings shall be finished with an eight ounce canvas jacket neatly applied using adhesive.
f. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and pre-molded sections, plus white vapor seal mastic, plus Manville Calcoat-127 insulating finishing cement to smooth surfaces, plus canvas applied and sized for painting with fire resistant adhesive. In addition, all manufactured vapor barrier jacketing in mechanical rooms and finished spaces shall be finished with canvas applied and sized for painting with fire resistant adhesive.
g. No chilled water pipe supporting structures shall pierce the insulation except as anchor points as shown on the Drawings. At these points, the anchor member shall occur on the bottom of the piping to allow condensation to drain.
h. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings.
i. All insulation joints (longitudinal and butt) shall be buttered with vapor sealant mastic then pressed firmly together.

2.3 TYPE C: PHENOLIC FOAM

A. Phenolic Foam by ITW Trymer or equal with a "K" factor of 0.19 BTU-In/Hr.-degree F at 75°F.

1. Rated maximum service temperature of 257°F.

2. Maximum density of 3.75 lbs/ft^3

3. Compressive strength of 45 psi minimum when tested in accordance with ASTM C165.

4. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.

5. Certified to meet the requirements of ASTM C795 for use over stainless steel.

6. Rated as noncombustible when tested in accordance with ASTM E136.

7. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

8. Installation: As Type B, above.

2.4 TYPE D: FIBERGLASS

A. Owens Corning or equal glass fiber insulation piping insulation with a "K" factor of 0.23 BTU-In/Hr.-degree F at 75°F and 0.32 BTU-In/Hr.-degree F at 250°

1. Rated maximum service temperature of 850°F.

2. Maximum density of 3.5-5.5 lbs/ft^3

3. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.

4. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.

5. Certified to meet the requirements of ASTM C795 for use over stainless steel.

6. Rated as noncombustible when tested in accordance with ASTM E136.

7. Insulation treated with water resistant resin on the surface and within each layer of the insulation.

8. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

2.5 TYPE E: CLOSED CELL ELASTOMERIC

A. Closed cell elastomeric piping insulation with a "K" factor of 0.25 BTU-In/Hr.-degree F at 75 F as manufactured by Armacell or equal.

1. Rated maximum service temperature of 220°F.

2. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.

3. Certified to meet the requirements of ASTM C795 for use over stainless steel.

4. Rated as noncombustible when tested in accordance with ASTM E136.

5. Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint.

6. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

2.6 TYPE F: HIGH TEMPERATURE FIBERGLASS

A. ESLIN EG-SCUI or equal glass fiber insulation piping insulation with a "K" factor of 0.30 BTU-In/Hr.-degree F at 200°F and 0.48 BTU-In/Hr.-degree F at 600°

1. Rated maximum service temperature of 1200°F (650°C).

2. Maximum density of 12.5 lbs/ft^3

3. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.

4. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.

5. Certified to meet the requirements of ASTM C795 for use over stainless steel.

6. Rated as noncombustible when tested in accordance with ASTM E136.

7. Insulation treated with water resistant resin on the surface and within each layer of the insulation.

8. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

2.7 PROTECTIVE JACKETING

A. Aluminum Jacketing and fitting covers: 0.016 aluminum smooth as manufactured by Gasco, Papco RPR Metals, Childers, or equal. The jacket shall be pre-cut, pre-rolled, and lapped a minimum of two inches (2") In all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.) ¾" wide .020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016" aluminum or stainless steel with a smooth finish.

B. PVC Jacketing: Proto Corp. LoSmoke PVC jacketing and fitting covers Material shall have 25/50 rating and shall be limited to piping systems operating at 140 degrees or below.

2.8 INSULATED UNDERGROUND PIPING

A. See Section 23 20 00.A.

PART 3 - INSTALLATION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions in the absence of specific instruction herein.

B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the "90°" position, with the seam lapped such that the lap is directed down.

C. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

D. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

E. If PVC fitting covers are used they shall have 25/50 rating.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

3.3 INSERTS, SUPPORTS AND SHIELDS

A. Application: Piping 3/4 inch diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be

used between the hangers or support points and the bottom of the insulated pipe for insulated pipes 3/4" and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS	Metal Thickness of Shield	Lengths
up thru 2"	14 gauge	12"
thru 6"	12 gauge	16"
and above	10 gauge	20"

C. Insert Location: Between support shield and piping and under the finish jacket.

D. Insert Configuration: Minimum 2" inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

F. The shields at support points shall be secured with ½" x 0.016" stainless steel bands and seals.

G. Finish insulation at supports, protrusions, and interruptions.

H. In lieu of the above the following system of support may be used:

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft3 phenolic foam material to withstand the bearing loads transmitted from the pipe to the support; it shall extend for at least 1" on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1" thickness of 2.2 lbs/ft3 standard insulation including FSK/ASJ vapor barrier.

Table 1: K Block Support Centers

Nominal Pipe Size (Inches)	3/4	1	1 1/4	2	2 1/2	3	4	6	8	10	12	14	16	18	20	24
Max support centers (feet) Sch 80 pipe filled with water covered with 1" of Standard Insulation	6.5	6.5	6.5	10	10	10	10	10	14	14	14	20	20	20	20	20
Metal Saddle Gauge (Galvanized Steel)	22	22	22	20	20	20	16	14	14	14	14	14	114	14	14	14
Length of HLB Block (inches)	6	6	6	6	6	6	6	9	9	9	9	9	9	12	12	12

3. The Insulation at supports shall be Foamglas HLB Blocks. HLB Blocks shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel 1800 saddle bonded to the bottom section of the HLB Block, for all pipe sizes 1 1/2" and larger.

4. The vapor barrier shall be completed by the use of a FSK/ASJ overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

5. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval.

6. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

I. For purpose of definition in this Specification: “concealed” areas are those areas which cannot be seen by the building occupants, and “exposed” areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

J. Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.

K. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140 degrees F on the hot surfaces.

L. Special Protection: All insulated piping in the mechanical rooms within 8’-0” of the floor shall be encased in a protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

3.4 PAINTING

A. All exposed insulation shall be prepared to receive painting specified under Section 09 91 00.

3.5 INSULATION APPLICATION SCHEDULE

A. All insulation R-Values shall be the greater of what is scheduled below or required to meet ASHRAE 90.1-2010.

B. Where minimum scheduled thickness exceeds the thickness required to meet the minimum R-Value, provide the minimum scheduled thickness. Insulation Thickness depends upon insulation type used.

Service	Pipe Dia. (Inches)	Fluid Temp (^oF)	Min. R-Value (ft^2 ^oF-hr/BTU in)	Insulation Thickness (Inches)		
Chilled Water		<40		Type B	Type C	
	<1"		3.2	1	1	
	1 to <1 1/2"		6.4	1	1	
	1 1/2" to <4"		5.7	1	1	
	4" to <8"		4.7	1	1	
	>8"		4.3	1 1/2	1	
Service	Pipe Dia. (Inches)	Fluid Temp (^oF)	Min. R-Value (ft^2 ^oF-hr/BTU in)	Insulation Thickness (Inches)		

1. All insulation R-Values shall be the greater of what is scheduled above or required to meet ASHRAE 90.1-2010.

2. Use the following jacket types: in concealed interior spaces: All Service Jacket; in interior mechanical spaces: Aluminum Jacket up to 8 feet above floor and All Service Jacket above 8 feet above floor; in tunnel and exterior spaces: Aluminum Jacket.

3. Minimum ‘R’ does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

4. A minus 15 percent tolerance on the insulation performance listed shall be permitted for manufacturers' standard insulation systems.

END OF SECTION 23 07 19

SECTION 23 08 00 COMMISSIONING OF HVAC SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for HVAC systems, assemblies, controls, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

1.2 RELATED SECTIONS

A. SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

B. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS

C. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

1.3 DEFINITIONS

A. Refer to SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.4 SUBMITTALS

A. Certificate Of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for details of HVAC contractor’s responsibilities related to commissioning.

B. Perform commissioning tests at the direction of the CxA.

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

F. Functional testing of systems will be carried out solely by Mechanical contractor's personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.6 CxA'S RESPONSIBILITIES

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete. Review and comment on testing, adjusting, and balancing report.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.

C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

E. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that HVAC and controls systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.4 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.

B. Provide measuring instruments and logging devices to record test data as directed by the CxA.

3.5 CONTROLS TESTING

A. Submit to CxA all documentation and reports called for in specifications SECTION 23 0900 - INSTRUMENTATION AND CONTROL FOR HVAC.

1. Verify communications interface with central operator station, all controllers on LAN, and remote communications devices.
2. Verify operation of web browser interface.
3. Verify page navigation functions correctly.
4. Verify BAS contractor has calibrated all analog sensors per specifications. Verify sensor accuracy and reasonableness.
5. Verify correctness of graphics: schematics reflect actual installation, all specified all specified input and output points are displayed, spelling is correct, proper units (e.g., deg F, psi, etc.) are used, layout is logical and consistent, floor plans are accurate and identify locations of equipment, thermostats, etc.
6. Verify auxiliary items (printers, screens, computers, etc.) are supplied and functioning.
7. Verify operation of all input and output points by forcing point, changing setpoints and observing reaction, etc.
8. Verify correct operating sequences, including setpoints.
9. Verify communications with / points display of Modbus and Bacnet controllers of stand-alone equipment items.
10. Verify that equipment alarms register at BAS, and are stored in history log.

B. Trend Logging:

1. Set up historical trend logs to record data points from any and all systems as directed by CxA. The logging frequency and duration of logging will be set up as directed by CxA, and all logged data will be permanently stored, and transmitted to CxA at intervals as directed by CxA.

3.6 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
2. Failure of an item (other than sound) includes a deviation of more than 10 percent from specified value, or other more stringent requirement if called for elsewhere in this project manual. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
3. Remedy the deficiency and notify CxA who will re-verify failed portions of test.

3.7 PIPING SYSTEMS

A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.8 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.

2. If tests cannot be completed because of a deficiency outside the scope of the Mechanical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.9 RE-TESTING

A. Reference Project Specification Section 01 09 13 COMMISSIONING GENERAL REQUIREMENTS for detailed requirements of re-testing of Mechanical systems.

3.10 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for list of Mechanical systems to be commissioned.

END OF SECTION

SECTION 23 09 23A - DIRECT DIGITAL CONTROL SYSTEMS

PART 1 GENERAL

1.1 Section 23 00 00 - Basic Mechanical Requirements to be included as if written herein.

1.2 WORK DESCRIPTION

A. Scope: This section contains general requirements for the supply and installation of a Building Automation System (BAS). It is the intent of this specification for the BAS to be installed as a complete package by the Controls Contractor. The Contractor shall certify all work as proper and complete and shall reflect actual installation on the project record documentation. The system shall include all computer software and hardware, controllers, sensors, transmission equipment, local panels, installation, engineering, supervision, commissioning, acceptance testing, training, and warranty service.

B. The Mechanical Design Engineer (MEP Engineer) must provide a Control Diagram and a Control Sequence of Operation narrative for each typical piece of mechanical equipment. The Control Diagram must include an equipment schematic and each control input and output (sensor, actuator, VFD, start/stop, etc.) Typical HVAC Control Diagrams and Sequence of Operations (SOO) templates are available from the UT Austin BAS Engineer. The MEP shall also include the CAD files necessary for the Controls Contractor to complete their project work. The CAD files must be the same files as those in the project contract. The Controls contractor must not use these files for any other purpose than to perform the project work.

C. The Controls Contractor shall be responsible for furnishing and installing all equipment and low voltage wiring and conduit for the Building Automation System for a complete and operable system as specified herein. All installation shall be under the direct supervision of the Controls Contractor. All conduit and wiring shall be installed in accordance with local and national codes, with the equipment manufacturer's recommendations, and with the Division 26 Electrical Specifications.

D Project Bidding – If a General or Prime Contractor is involved in the project, the HVAC Controls Contractor shall bid directly to the General or Prime Contractor. The HVAC Controls Scope of Work may be re-assigned at the General or Prime Contractor's discretion.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Mechanical Contractor (Division 23) - Products furnished, but not installed under this section include air flow stations, automatic control dampers, control valves, flow switches, flow meters, thermo-wells and pressure taps for BAS instruments. These are to be installed by the Mechanical Contractor.

B. Air Terminal Units - Control components are to be provided by Controls Contractor and factory installed by terminal unit manufacturer under Specification 23 36 00 – Air Terminal Units.

C. Electrical Contractor (Division 26) –Provide and install material as specified in this specification Section 3.4, Electrical Installation Practices under Division 26.

D. Variable Frequency Drives – see Specification Section 23 29 23.A to specify, provide and install VFDs.

1.4 QUALIFICATIONS

A. System components shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

B. The control system shall be furnished, designed, and installed by factory trained and certified technicians who can also provide timely instruction, routine maintenance and emergency service upon receipt of request.

C. The control system components, installation and operation shall be in conformance with the latest revision of the following applicable standards:

1. ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-rise Residential Buildings
2. American Society of Testing and Materials, ASTM
3. Institute of Electrical and Electronic Engineers, IEEE
4. National Electrical Manufacturers Association, NEMA
5. Underwriters Laboratory, UL (UL 916 & 864)
6. FCC Regulation, Part 15, Section 156
7. National Fire Protection Association, NFPA
8. Local Building Codes

1.5 SYSTEM DESCRIPTION

A. Automatic temperature, humidity, and pressure control and monitoring using microprocessor-based controllers with communications to central monitoring/control station.

B. The BAS includes hardware, firmware, and software necessary to obtain the performance requirements by function and system components for operation, reliability, security, packaging, control sequencing, alarm reporting, scheduling, loop tuning, trending, interlocks, and system integrations.

C. The BAS includes equipment such as operator workstations, direct digital control (DDC) controllers and enclosures, field devices, terminal equipment, circuit breakers, and transformers.

D. Included with field devices are all sensors, transmitters, transducers, wells, relays, switches and power supplies with associated wiring, conduit, cabling, mounting, and enclosures necessary for complete operation of the system.

E. Also included are control valves, dampers, valve actuators and damper actuators necessary for a completely functional system in accordance with the sequence of operation.

1.6 SYSTEM PERFORMANCE

A. Provide controllers that execute PID control loops at a frequency not to exceed 1 second. The process variable scan and updated calculated output rate is at same rate.

B. Custom and standard application execution times must be consistent with or faster than mechanical processes under control.

C. Graphics update rates:
1. Display Refresh: 20 dynamic points in 5 seconds, with automatic refresh every 20 seconds
2. Object Command: 2 seconds
3. Object Scan: 2 seconds
4. Alarm Response Time: 5 seconds when point goes into alarm

5. Multiple alarms: 3 seconds of each other

D. Control Loop Stability:
1. Air Pressure: ±0.2” wg
2. Airflow: ±5% of actual flow
3. Temperature: ±1˚F
4. Humidity: ±5% RH
5. Fluid Pressure: ±2% of full scale
6. Fluid Flow: ±2% of full scale

1.7 SUBMITTALS, DRAWINGS & EQUIPMENT DATA

A. Submit under provisions of Section 23 00 00.

B. Provide 4 copies to the Owner for review plus the number of copies the Contractor wants returned.

C. All shop drawings shall be prepared on AutoCAD, (verify latest version compatible with UT drafting standards). Electronic drawing documents shall be archived in a PDF format. Hardcopy drawings shall be minimum B size (11"x17") and not larger than D size (24"x36").

D. Shop drawings shall include plans of enclosure locations and riser diagrams depicting locations of all controllers with associated network wiring. Drawings shall include wire and terminal numbering related to input and outputs (I/O) for each controller. Each I/O shall be labeled with the associated field device name. Typicals shall be allowed where appropriate (for example, terminal equipment controls). Labeling of equipment and wiring on the drawings shall be consistent with field labeling.

E. Provide a listing of point loading for each controller. The listing shall detail input and output points and shall include a description of equipment each point serves. Clearly indicate which points attach to controllers and which points attach to expansion modules. Multiple points associated with a particular piece of equipment shall be sequentially grouped onto the controller’s input and output terminals.

F. Submittal shall include project specific information and options proposed for all hardware and software products required by the specification, including equipment technical data sheets and drawings. Equipment shall be listed in a master bill of material at the front of the submittal. Bill of material shall list device name, manufacturer, model number and accuracies, with complete part numbers, indicating and describing all options being proposed for all components.

G. Submittal shall include manufacturer’s catalog data describing and specifically indicating each item of equipment or component provided and installed for the project.

H. In addition, submittals shall include:

1. Symbols legend and table of contents.

2. Valve and damper schedules. Valves schedules shall include as a minimum associated system name, service, drawing reference, quantities, model and code information, configuration, fail position, pipe size, valve size, body configuration, close off pressure, flow data, design and actual Cv, design and actual pressure drop, valve top model and code information, and spring range. Damper schedule shall include as a minimum associated system name, service (return, relief, outside, lateral, etc.),

quantity, model and code information, size, fail position, actuator code and model information.

3. Descriptive point list delineated by each piece of controlled or monitored equipment.

4. Sequence of operation.

5. Power riser diagrams depicting layout of all controller enclosures. Include power circuiting and enclosure room locations. Indicate which controllers receive UPS power.

6. Diagram depicting the system architecture, complete with communication riser diagrams depicting layout of controller enclosures and cabling.

7. Construction plans detailing locations of all mechanical equipment, suggested locations for BAS enclosures and approximate locations for field devices.

8. Schematic diagrams of HVAC equipment and associated points with wiring nomenclature.

9. Proportional drawing of enclosure interior device layout. Drawing shall depict high and low voltage sections, controllers, power outlet, terminal strips, power supplies, transformers, fuses, surge suppressers and wire management. Include device sizing information (i.e. fuse sizes, etc.) and bill of material.

1.8 OPERATION, MAINTENANCE, AND CONSTRUCTION DOCUMENTATION

A. Submit record documents under provisions of Section 23 00 00. All record documents are the property of the Owner. The Controls Contractor may maintain copies of record documents as needed to continue performing work on campus, but the Owner must approve the release of these documents.

B. Include data specified in "Submittals" in final "Record Documents" form.

C. Revise shop drawings to reflect actual installation and operating sequences.

D. Prior to Final Acceptance, the Controls Contractor shall prepare and deliver to the Owner 3 sets of organized and bound operation and maintenance manuals and 1 electronic copy in pdf, doc, or xls format. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the installed BAS.

This documentation shall include:

1. Record drawings, including schematics and floor plans, indicating final locations of field installed components, including mechanical equipment, controllers, and zone points.

2. Hardcopy and electronic media of as-built drawings.

3. Controller specific point lists including controller and point names and descriptions. Respective point lists shall be installed at each controller as well as included in the final manuals.

4. Manufacturer’s catalog data and specifications, with specific equipment part numbers, for sensors, transmitters, controllers, control valves and actuators, damper actuators, gauges, indicators, terminals and any miscellaneous components used in the system.

5. Communications riser diagram as installed with communication cable lengths by segment. Submit as-built floor layout drawing(s) showing the actual route of the cables.

6. Power riser diagram for all controller enclosures with power source electrical panel labels, circuit numbers and physical location within the building (room number). Submit as-built floor layout drawing(s) showing the actual route of the cables.

7. A copy of the warranty.

8. Operating and maintenance cautions and instructions.

9. Calibration requirements.

E. Documentation updates shall be provided to the Owner at no additional cost for the duration of the warranty period whenever the final accepted installed configuration is modified. Updates shall include but not be limited to changes made to equipment, hardware, controller and workstation software, controller programs and tuning constants. Only those documents affected by the changes shall be updated. At the end of warranty, provide a final electronic copy of all documentation including all modifications and changes during warranty.

F. Field Mounted Schematic Record Drawings and Point Schedules

1. Provide schematic drawings by equipment type (air handling systems, pumps systems, smoke management systems, etc.) including sequences, spring ranges, device normal positions and component ranges clearly written on the schematics.

2. Schematic drawings shall be laminated and permanently mounted on inside of front door of control panels.

3. Provide hardcopy point schedules at each controller location. Schedule shall list all points as installed including names, descriptions and I/O channels associated with the controllers at that location. Provide separate schedule for each controller.

4. Hardcopy schedule shall be encased in a transparent plastic protective sleeve and be securely fastened to the inside of the equipment enclosure door.

1.9 WARRANTY

A. Provide warranty under provisions of Section 23 00 00.

B. Compatibility: The Controls Contractor warrants that all equipment shall be fully compatible with the existing Andover Continuum BAS or the existing Siemens Apogee system, as applicable.

C. Warranty Period: All installation, equipment, and engineering services are warranted to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of project substantial completion. Longer warranty periods may apply based on warranties provided with specific pieces of equipment.

D. Warranty Cost: If during the warranty period any of the equipment, material, software, or programming provided, and/or furnished by the Controls Contractor is found to be defective it shall be replaced by the Controls Contractor at no cost to Owner.

E. Warranty Response: During the warranty period the response time by the Controls Contractor shall be a maximum of four (4) hours, twenty-four (24) hours per day, and seven

(7) days a week. Where the nature of the warranty work requires on-site work, the Contractor's response to a warranty request shall include an on-site presence of Contractor personnel specifically addressing the software and hardware needing warranty service. Where the warranty work can be accomplished off-site, the Contractor shall state so and indicate the amount of time required to accomplish the work and the methods utilized for performing the work.

F. Warranty Repair Documentation: For each warranty response, provide documentation back to Owner indicating which warranty item was repaired and what work was performed to remedy the problem. In addition to providing this document through project document channels, electronically communicate the same information to UT Austin Instrumentation and Controls Shop.

G. All changes made to the finally accepted system shall be documented.

H. Provide five year warranty for electric actuators.

1.10 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.1 BAS MANUFACTURERS

A. Johnson Controls Inc., Metasys System.

B. Siemens Industry Inc., Building Technology Division, with P1 and P2 protocol.

C. Individual buildings shall have either one of the above listed systems; no building is to have a combination of these systems.

D. The central monitoring facility shall have independent servers and operator workstations for the monitoring and control of each BAS system and remove application capabilities.

2.2 NETWORK ARCHITECTURE

A. Network configuration and topology consists of a server/client architecture. A primary application server and backup server interface with the system processes. The primary server is located remotely from the backup server. The system data is mirrored on the servers and automatically switches from primary to backup upon loss of a server.

B. Communication on first tier network is via the UT campus-wide VPN-WAN (FACnet), operating at a minimum of 100 Mbps, for interconnecting the servers, workstations, and building controllers, using PC industry standard of Ethernet TCP/IP.

C. Second tier networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, operating at the fastest available communication speed, with a minimum of 9600 baud. When necessary, provide repeaters to detect and repeat signals from one second tier, building-wide LAN segment to other segments.

D. System information is provided to users outside of the secure network via a web server, which is a separate server from either the primary or backup servers. Information is delivered to user desktop computers via UT campus network (UTnet) and system must comply with UT firewall and security requirements.

E. Building communications connections shall be provided by UT. Coordinate location and cabling details with UT. Network cable termination jacks shall be located in a lockable control enclosure for limited access.

F. Modems, wireless devices or other remote type communication devices, which circumvent network security, shall not be used for access to the BAS.

G. To prevent security breaches and viruses in the secure WAN, at no time shall any device be connected to the WAN that has been connected to any other network. This applies to network controllers, workstations, laptops, servers, and other equipment that utilizes TCP/IP Ethernet protocols and are intended for operating on the first tier network.

H. The BAS shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS and third party manufacturers' control panels. Integration shall be via EIA-232 or EIA-485 technologies.

I. Provide gateways for integrating third party systems using BACnet or Modbus, protocols. OPC servers can also be used for diverse system integration. The OPC server shall have the following characteristics and functionality:

1. Run on Windows latest version, compatible with UT standard, connected via Ethernet to the BAS.

2. Allow generic components to be used and shared with other OPC-compliant clients and systems.

3. Serve as the "translation service" for the various languages used by the diverse systems with which it communicates.

4. Support multiple OPC clients running on both local and remote machines in the network.
5. Control the interaction and communication between workstation applications (on clients) and the BAS by providing standard methods for sharing and exchanging data between the BAS and other systems.

6. Provide interfaces for browsing, reading, and writing accessibility.

J. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients.

2.3 OPERATOR STATION

A. Utilize existing operator workstations in the central control room. Network and system hardware, components and software not existing as part of Owner's BAS system as listed below, shall be provided as part of the project.

B. Operator workstation based on Dell commercial off-the-shelf personal computer (PC) hardware, including:

1. Flat panel monitors
2. Network interface card
3. Sound card
4. Mouse

5. Keyboard
6. Interconnecting cabling

C. Provide all network and system hardware and application software required for a complete and functioning system. Where vendor software requires additional hardware, Contractor shall provide hardware to meet these needs.

For each BAS system, the following hardware requirements are intended as minimum requirements.

1. One network primary server plus one backup server; locations to be determined by Owner.

2. One WEB server with appropriate firewalls; location to be determined by Owner.

3. One alarm report workstation located at the Central Monitoring computer room.

4. Three workstations located at the Instrumentation and Controls Shop.

D. If specifically required by the controls construction contract, provide one laptop for use by the Owner as a monitoring, field calibrating, and commissioning tool. The laptop is to be provided complete with application software and all necessary programs to match workstations. The laptop is to be configured as a workstation on the network at time of delivery. The laptop shall not be used by the Contractor on the project but shall be provided new and unused to the Owner.

2.4 DIGITAL CONTROLLERS

A. Programmable controllers are required for all major equipment. Programmable controllers or Application Specific Controllers may be used for small constant speed fan coil units, small constant speed exhaust fans and air terminal units.

B. Programmable Equipment Controllers

1. Controllers shall be applied to maximize the stand-alone operation of the BAS System. Real-time control functions shall be resident in the BAS controllers to facilitate greater fault tolerance, independence, and reliability. Separate controllers shall be distributed and used for each logical group of major mechanical and electrical equipment or building system. Combining points from different equipment groups or systems onto single controllers shall not be acceptable unless prior approval from the Design Engineer is obtained. Logical number of controllers is project specific and must be defined by the Design Engineer. Centralized controllers where wiring from multiple systems is “homerun” to single controllers are not acceptable.

2. Global points requiring passage over a network for input into a controller shall be limited to those absolutely necessary and shall be approved by the Owner prior to use. Where global points are used, the Contractor shall provide programming provisions for loss of global information due to network failure. Signals needed for equipment operation during emergencies shall not use public network wiring because it may have failed. In general, it is acceptable to make outside air conditions and occupied/unoccupied flags available globally.

3. Provide local stand-alone controller with sufficient memory for all control programs and logging functions for the equipment group being controlled.

4. Each major equipment controller shall be provided with spare input/output capacity or capability for future expansion. Provide a minimum of two analog inputs, two analog outputs, two binary inputs, and two binary outputs, or equivalent configurable points, directly on the controller or with capability for future expansion by means of expansion modules. Leave extra space inside enclosure for future expansion modules. Spare capacity within a controller enclosure meeting all the requirements for all controllers in the enclosure is acceptable.

5. Each controller analog outputs shall be true analog outputs of 0-10 VDC or 4-20 ma. Use of pulse width modulating or tri-state outputs is not acceptable for major equipment programmable controllers.

6. Analog input function shall be 10k Ohm Type 2 or Type 3 thermistor, 4-20 ma, 0-10 VDC (2.5 mV resolution), 0-5 VDC (5.0 mV resolution), counter or digital.

7. DDC controllers shall be provided with one RS-232C serial data communication port for the portable laptop operator's terminal. When a modem is required for remote operation, a second RS-232C serial data communication port shall be provided. DDC controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or terminals.

8. On major equipment controllers, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points. Switches shall be mounted within the DDC controller's key-accessed enclosure.

9. DDC controllers shall provide local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated analog indication of value shall also be provided for each analog output.

10. Each DDC controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The DDC controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failure to establish communication.

C. Network Controllers

1. Interface applications specific controllers together, to other network segments, and to the system servers/operator workstations.

2. Provide microprocessor-based controller:
   a. Word size of 16 bits minimum
   b. Scan rate 1 second (maximum)
   c. Memory as needed for its self function and lower tier controllers
   d. Real time clock
   e. Communications:
      i. Open system protocol
      ii. Two EIA-232, RS-485, or Ethernet ports
   f. Base installation shall utilize a maximum of 80% of controller capacity, and 20% spare for future use.
   g. Each Network Controller shall be capable of storing trend and point history data for all analog and digital inputs and outputs.

h. Network Controllers shall be fully user-programmable supervisory controllers. The Network Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers. Controllers shall be listed by Underwriters Laboratories (UL).

2.5 APPLICATION SPECIFIC CONTROLLERS (ASC)

A. General Information

1. All control points used by an ASC control program must be visible on the front end BAS screens for aid in operation and troubleshooting the controlled equipment.

B. Terminal Equipment Controllers (TEC)

1. The controllers shall include all inputs and outputs necessary to perform the specified control sequences. Outputs may be analog or 24-volt floating.

2. Each controller performing space temperature control shall be provided with a matching room temperature sensor with a setpoint adjustment between 55˚F and 95˚F.

3. Setpoint adjustment and override function shall have the ability to be locked out, overridden, or limited as to time or temperature through software by an authorized operator at the central workstation, at the DDC Controller, or via the portable operator's terminal.

4. Each TEC shall perform its primary control function independent of other controllers. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control and shall facilitate optimal occupant comfort and energy savings.

5. Provide each terminal equipment controller with sufficient memory to accommodate point databases and operating programs. All databases and programs shall be stored in non-volatile EEPROM, EPROM, and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure. Operating programs shall be selectable and may be modified to meet the user's exact control strategy requirement, allowing for additional system flexibility.

6. Controllers shall be powered from a 24 VAC source, and shall function normally under an operating range of 18 to 28 VAC (-25% to +17%), allowing for power source fluctuations and voltage drops. The controllers shall also function normally under ambient conditions of 32˚ to 122˚F and 10-95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assemble.

7. Pressure independent controllers shall include differential pressure transducers that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert his value to actual airflow. The differential pressure transducer shall have a measurement range of 450 to 4,000 FPM and measurement accuracy of ±5% at 450 FPM ensuring primary airflow condition shall be controlled and maintained to within ±5% of setpoint at the specified parameters. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and ensuring against drift over time. The controller requiring 24 hours a day operation shall calibrate the airflow sensor every 24 hours with the use

of an auto-zero module to eliminate the requirement for closing the supply damper to calibrate the flow sensor.

2.6 OPERATING SYSTEM SOFTWARE

A. Software needed for complete and functioning operation shall be provided for all hardware. The server shall include all operating system, network, database, etc. software applications for complete functionality. Workstations shall include operating system and all application software including vendor specific software for complete functionality. Laptops shall include operating systems and all application graphical software including vendor specific software for functionality as a system service tool.

B. All controllers, network and ASC, shall utilize the same programming language for all applications including implementation of control algorithms, alarms, pseudo points, etc.

C. The Contractor shall use their standard software library for all system and controller programs.

D. The Contractor shall prepare, install, configure, and debug all software necessary for complete operation of the BAS and related systems, including the loop control statements, algorithms, and tuning constants required to achieve the Sequence of Operation. Control algorithms shall be manufacturer's standard PID control loops or other Engineer approved control algorithms.

E. All system data, controller programs, historical and trend data shall be archived in the system server database. System shall be provided with backup of this database. Backup shall include mirroring of data to backup server as well as provisions for removable media backup. Provide program which allows saving and restoring of operating data.

F. Operator Access Control: Restrict any operator commands through use of software password. Provide capability for a minimum of 5 levels of access related to system operational control, monitoring, and programming functions.

G. Information Access: Obtain point status information from any designated output device with access command. Point status consists of point identification, numerical value (analog points) and associated engineering units, and individual function label indicating that point is on or off or in Alarm Normal condition. Output includes date and time of execution.

H. Point Display: Video display includes status of single point or group of points with high and low limits (if applicable). Refresh display at least every 20 seconds.

I. Provide diagnostic programs with alarms to alert the operator upon detection of a fault.

J. Provide BAS software to re-initialize system upon fault restoration, unless operator intervention is deemed necessary.

K. Provide BAS software so that the system will fail in a manner following the sequence of operation, to ensure integrity and safety of system equipment and operation.

L. Provide programming to automatically and safely restore systems to normal operating conditions following a power outage and to enforce emergency operating conditions during the power outage per the sequence of operation. To avoid electrical equipment overloads restart major HVAC equipment at 30 second delayed intervals. Equipment restart shall be programmed for either operator intervention or automatic initiation as selected by the system operator. Operator intervention shall be accomplished graphically. Provide summary graphics associated with equipment power-up, which depict equipment name, status, start command, current program line and controller power status.

M. Provide programming for interface of BAS with smoke management system as required.

2.7 WORKSTATION GRAPHICS

A. All workstation graphics shall be developed and installed by the Contractor. Sample graphics are either attached to the contract documents or will be provided by the Owner upon request. All graphics implemented for the project shall conform to Owner's standards and be approved by the Owner in accordance with the Project Review milestones.

B. Graphics shall reside on BAS servers to which all workstations on the network have access. Graphical server shall be an independent, stand-alone server and not operate as a user workstation. Server graphics shall be uploadable and downloadable to workstations through the wide area network. Sharing, updating and reloading of graphics by any other means than through the wide area network shall not be acceptable.

C. Provide system navigation graphics including as a minimum the following graphics: Provide additional graphics as required by specific needs of a project.

1. Building Grid: Provide a tabular grid containing the three-letter acronym for each building. The building acronyms shall be arranged alphabetically on the grid.

2. Building Main Graphic: Each building shall be provided with a main graphic to which other building specific graphics shall be linked. Links shall be embedded on each floor plan that navigates to an enlarged floor plan. The Building Main Graphic shall also display the building current active alarm count, links to all building specific graphics, links to all menu/navigation graphics and building restart graphics. Link back to the Campus Grid shall be provided. Each sub-graphic for a building will contain the following building specific information: Outside Air Temperature, Outside Air Humidity, Building Occupancy, Power Monitoring Status and Fire Alert. Note as N/A when not applicable.

3. Building Floor Plan Graphic: For multiple terminal units, provide an enlarged floor plan, which shall display room temperatures, room humidities and provide links to Building Equipment Level graphics. Provide single line diagram showing location of terminal unit and all rooms served by each terminal unit. On each floor plan graphic, provide navigation links to all building levels and menus with links to other building graphics.

4. Equipment Level Graphic: As a minimum provide one graphic for each HVAC system including fan systems, chilled water systems, hot water systems, steam systems, return fan systems and other systems as appropriate for project specifics. Provide a schematic diagram for each HVAC system that shows all BAS controlled and monitored components associated with the system. The diagram shall include embedded real time information for all controlled, I/O and associated variables including calculated values, flags and alarm limits. Include the location (room #) of the HVAC equipment, and the locations that the equipment serves (rooms and/or floors).

5. Building Summary Graphics: Provide graphics that group information together for ease of building systems diagnostics. Summary graphics shall include the following: Alarms, Motors, Temperatures, Controller Status, Floor Pressures, and Filter Differential Pressures.

6. Terminal Unit Graphic: Information for real time zone information shall be presented on Building Floor Plan Graphic. Provide a summary graphic for groups of zones, which allow quick visual review of operating conditions. Provide link to each individual terminal unit graphic.

7. Sequences of Operation: Provide a link on the building main page graphic which contains the control sequence operation narrative for each piece of equipment.

D. Logically locate and display all field device input and calculated values on the graphic with proper engineering units (Normal, Alarm, On, Off, PSI, GPM, CFM, % Open, etc.)

E. Provide point value colors or equivalent distinction as follows: AI/AO=blue, DI/DO=green, Calculated=aqua, Fixed=yellow, Disabled=magenta.

2.8 WORKSTATION ALARMS

A. Provide red graphic alarm navigation for Building Grid and building graphics. This includes navigation to equipment via graphic buttons that turn red for the respective building on the campus grid and red for the respective building graphic buttons when a system component is in alarm. Red navigation shall “drill-down” to the specific alarm in the building and provide for ease of operator navigation to a specific piece of equipment in alarm. When equipment is not in alarm, buttons shall show their non-alarm color.

B. Alarm programming shall consist of three simultaneous modes of operation: reporting through an active alarm window, red navigation, and archiving and reporting.

1. Points or buttons in alarm shall turn red on the graphic screen where they are located.

2. If there are from 6 to 15 separate alarms underneath a linking button, the linking button shall blink red.

3. If there are more than 15 separate alarms underneath the linking button, the linking button shall blink yellow.

4. Active Alarm Window: Critical Alarm Response System (CARS) alarms and building generic alarms shall report to the active alarm window on the Operator’s Workstation. CARS alarms shall be determined with Owner input on a project-by-project basis. CARS alarms shall turn brown on the active alarm window, to stand out from other alarms.

5. Archiving and Reporting: All alarms shall be archived within the BAS system database. Provide an alarm report tool which resides on an alarm report workstation that is separate from operating workstations. The report tool shall incorporate a report-writing feature that allows users to filter information to extract alarm information based on user-defined criteria including date (specific dates and ranges), alarm type, building, criticality, etc.

C. Initiate an alarm message if a point fails to respond, responds with wrong value, or drifts from a setpoint value by defined limits. Provide a feedback delay timer to temporarily suppress alarms to avoid nuisance alarms. Alarm each analog input to high and low limits (adjustable) around its normal operating value. Start with +/-10% limits around the normal value and adjust limits as needed.

D. Automatic Alarm Lockout: Automatically inhibit alarm reporting of analog and binary points upon associated system shutdown. Inhibit reporting for operator predetermined time, upon restart of HVAC systems.

E. Alarm Reporting:

1. Alarm outputs contain descriptor, point identification, point data, engineering units, and date and time.

2. Display multiple alarms in order of occurrence.

F. Alarm Messages:

1. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, and hardware elements advisories.

2. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

G. Advisories:

1. Lockout summary that contains status of points in locked out or disabled condition.

2. Continuously interrogate system hardware and programmable control units for failure or tampering and report if operational or not operational.

3. Power failure detection, time and date.

4. System communication failure with operator device, field interface unit, point, programmable control unit.

2.9 TRENDING

A. Provide capability to trend all points. Group points with interrelated process variables onto the same trend and as appropriate for historical data trends. Point groupings shall be proposed by the Contractor and approved by the Owner prior to commissioning of the control system.

B. Historical data collection utilities shall be provided to manually or automatically sample, store, and display system data. Collect data for all analog points, on major equipment controllers, at 15-minute (adjustable) intervals of instantaneous, average, high, or low information for a total of 288 (adjustable) points of data. The selection of instantaneous, high, low, or average data shall be based on type of point and shall be proposed by the Contractor for review by the Owner. Extended historical data shall be optionally stored and archived in appropriate data collection locations in the BAS for user reference.

C. Historical trends shall be accessible graphically from any workstation on the BAS network. The user interface for accessing the trends shall consist of an application that allows the user to individually select which historical trend to view. The main selection graphic shall include appropriate labeling of each of the trend groupings for navigation by the user to the desired trend.

D. Any point, physical or calculated, may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data. All trend data shall be available for use on third party personal computer applications such as Excel.

E. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.

F. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

2.10 OCCUPANCY SCHEDULING

A. Provide automatic, twenty-four hour/seven days a week schedules and programming that manages equipment on/off or setpoint resets and overrides unoccupied times. Each room temperature sensor shall have occupied and unoccupied heating and cooling temperature setpoints.

B. Scheduling:

1. Provide separate schedules for each equipment group as specified by the Owner.

2. Install an initial default schedule where Occupied = 6:00 am – 11:00 pm, to be adjusted later by the Owner.

2.11 WEB BROWSER

A. Provide web browser access for all BAS graphic screens.

B. Provide a thin client web browser function, through the UT Austin campus WAN (UTnet) which is protected by a firewall, with an intuitive mouse/menu driven interface.

C. The web browser must work with the current version of the MS Window operating system and MS Internet Explorer or Mozilla Firefox, with up-to-date patches.

D. Provide security and access control through a login page that requires a user login and password. UT Facilities I&C Maintenance will assign user IDs, passwords, and permission privileges.

2.12 POWER SUPPLIES

A. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure. Unit shall operate between 32°F and 120°F. EMI/RFI shall meet FCC Class B. Line voltage units shall be UL recognized and CSA listed.

B. Internal or external transient voltage and surge suppression shall be provided for workstations and controllers. Surge protection shall include:
1. Dielectric strength of 1000 V minimum
2. Response time of 10 nanoseconds or less
3. Transverse mode noise attenuation of 65 dB or greater
4. Common mode noise attenuation of 150 dB or greater at 40 - 100

C. Power surge and transient suppression shall be provided for each incoming power circuit serving a controller or group of field controllers. Surge suppressor shall be located in first controller enclosure where power is provided from the electrical panel. This suppression shall be in addition to any suppression contained within the controller hardware. Provide Kele model DTK-120HW surge protector or approved equal.

D. Low Voltage Power Supplies: Size power supply for 25% spare capacity over that required for equipment installed under initial installation. Output signal of each power supply shall be input into the BAS system that shall alarm on low or high voltage output. Power supply shall be Kele Model DCPA 1.2 or IDEC Model PS5R.

2.13 FIELD DEVICES - GENERAL

A. Field devices must be available from sources in addition to the BAS manufacturer. Brands other than the BAS manufacturer's brand must work with the control system so that training and spare parts are minimized. Exceptions are terminal unit damper actuators that are used with application specific controllers.

2.14 INPUT SENSORS

A. Temperature Sensors:

1. All temperature sensors shall be by the use of encapsulated moisture proof coated thermistors (10K ohm at 77˚F), type II or type III material.

2. Room Sensor shall be accurate to ±0.5˚F, over 55˚ to 80˚F range, and encased in a wall-mounted enclosure for mounting in a standard electrical box. Sensor housing and wall cover plate shall be one piece with override push button and setpoint adjustment integral with housing.
   Approved manufacturers and models:
   Kele, ES3-AO
   Siemens, series 1000
   TAC, ETR500 series

3. Duct Sensor: 10K thermistor, accurate to ±0.5˚F, over 0˚ to 130˚F range. All sensors in ducts shall be of the single point type and mounted on a standard duct bracket in location not affected by temperature stratification. Approved manufacturer and model: Precon ST-D series or Veris TJ series for plenum terminal units, or approved equal.

4. Averaging Sensor: 10K thermistor, accurate to ±0.5˚F, over 0˚ to 130˚F range. It must contain at least one sensor for every 3 feet, with a minimum tube length of 12 feet. See the Controls Diagram for installation locations. Approved manufacturer and model: Precon ST-FZ series or ACI A/AN-A-XX-GD series, or approved equal.

5. Outside Air Sensor: 10K thermistor, accurate to ±1˚F, over -30˚ to 130˚F range. Provide sunshield and watertight fittings if mounted outside. Approved manufacturer and model: Precon ST-O series or approved equal.

6. Immersion Sensors: 10K thermistor, accurate to ±0.5˚F, over 10˚ to 230˚F range. Sensors used in comparative applications shall be matched pairs. Provide stainless steel immersion well fitting, with Thread-o-let, for sensor and empty stainless steel well for test equipment. Pressure rating of well is to be consistent with the system pressure in which it is installed and must withstand the flow velocities in the pipe. Immersion length shall be ⅓ to ½ of the pipe diameter. Approved manufacturer and model: Precon ST-W Series or approved equal.

B. Humidity Sensors:

1. Wall mounted devices shall have appearance similar to temperature sensor devices. Cover shall be tamper resistant. When temperature element is required for same location, provide combination sensor. Provide 24 VDC power supply for sensor. Provide

calibration adjustments. Room-general: Accurate to ±2%, over 20 to 95% range. Approved manufacturer and model: Vaisala HMW92D or approved equal.

2. Duct: Accurate to ±2%, over 20 to 95% range. Sensor shall have a minimum 6" rigid probe. When temperature element is required for same location, provide combination sensor. Approved manufacturer and model: Vaisala HMD60 or approved equal.

3. Outside: Accurate to ±2% over 20 to 95% range. When temperature element is required for same location, provide combination sensor. Approved manufacturer and model: Vaisala HMD60 or approved equal.

C. Dew Point Sensor: Use a Humidity sensor (above) with a dew point calculation from temperature, or a direct dew point sensor. Approved dew point manufacturer and model: Vaisala Humicap HMT330 series or approved equal.

D. Static Pressure Sensors:

1. Duct Static: Accurate to ±0.1"wg over 0 to 5" range. Approved manufacturer: BaPI model ZPS series with display or approved equal.

2. Building or Room Static: Accurate to ±0.01"wg over 0 to 0.1" range. Approved manufacturer: BAPI model ZPS series with display or approved equal.

3. Filter Status Differential: Accurate to ±0.1"wg over 0 to 2" range. Approved manufacturer: BAPI model ZPS series with display or approved equal.

4. Steam: Provide transducer in watertight enclosure, with gauge, isolation valve, pressure snubber, and steam pigtail. Output signal to be 4-20 ma.
Approved manufacturer:
For low pressure, 0-30 psig range Kele PTX1EG-05 or approved equal.
For medium pressure, 0-100 psig range, Kele PTX1EG-07 or approved equal.

5. Water: Provide transducer with stainless steel wetted parts, 0-10 VDC output, bi-directional, with range selected according to specific application. Provide three-valve manifold assembly with Pete's Plugs and flush ports on the supply and return tubes for zero and span calibration and maintenance of sensor. Provide ½" brass body, stainless steel ball isolation valves at locations where sensor lines tap into fluid. For chilled water applications, provide minimum schedule 40 stainless steel nipples extended past insulation, between isolation valves and pipe thread-o-let. Approved manufacturer: Veris PW2 series wet/wet differential pressure transmitter or approved equal.

6. Instrument/Control Air Monitoring: Select sensor pressure range for nominal operation in upper 75% of range. Provide self-contained enclosure with integral pressure gauge. Provide 24 VDC power supply for sensor. Approved manufacturer: Kele model PSS2 series or approved equal.

E. Equipment Operation Sensors:

1. Status Inputs for Fans: Differential pressure transmitter with range as required for proof indication when equipment is at minimum flow. Approved manufacturer and model: BAPI model ZPS series or approved equal.

2. Status Inputs for Pumps: Differential pressure transmitter piped across pump, with pressure range matching system pressure range. Approved manufacturer and model: Veris PW2 series or approved equal.

3. Status Inputs for Constant Speed Motors or where Differential Pressure Sensing is Impractical: Motor Current Switch. Approved manufacturer and model: Kele CS or SCS series, or Senya C-2350 series, or Veris Hawkeye series.

F. Air Flow Sensors

1. Provide airflow traverse probes, either mounted in the ductwork or at the fan inlet, as indicated on the drawings, capable of continuously measuring the air volume of the respective ductwork or fan. This section does not apply to air flow sensors at terminal devices.

2. The airflow traverse probes shall be thermal dispersion type, with independent, multi-point sensing by bead-in-glass thermistors. Probes shall be of aluminum construction with hard anodized finish. Sensors shall not be adversely affected by particle contamination normally present in building system airflows.

3. The quantity of sensors and location of ductwork airflow traverse probes shall be per manufacturer's recommendations.

4. The airflow traverse probes shall not induce a measurable pressure drop nor shall the sound level within the system be amplified by its presence in the ductwork. The probes shall be capable of producing steady airflow readings, with an accuracy of 2% of actual flow.

5. Approved manufacturer: Ebtron, gold series for duct mounted, hybrid series for fan inlet mounted; or Ruskin EAMP or EFAMS Series.

G. Carbon Dioxide Sensors – CO2

1. Provide non-dispersive, infra-red (NDIR) carbon dioxide gas diffusion sensing and transmitting equipment, 4-20 ma and 0-5 VDC/0-10 VDC (selectable) analog output linear with CO2 measured. For duct-mounted applications, the CO2 sensing element shall be located in the airstream. The unit shall sense and transmit carbon dioxide readings from 0 to 2000 ppm linear with a minimum accuracy of ±5% of reading from 1000 to 2000 ppm and a repeatability of ±1% full scale. Input voltage shall be 24 VDC.

2. Approved manufacturers and models:
   Veris CDLS (duct) or CWLS (wall) Series
   BAPI BA/BS3F Series, combination CO2, temperature and RH sensors.

3. Provide sensors with one field calibration kit. Kit shall contain one tank with an 8-hour supply of 99.8% N2, one tank with an 8-hour supply of 1000 ppm CO2, one pressure regulator, one flow meter and a carrying case.

4. Wall mounted sensors shall be provided with LCD readout of CO2 sensed level and shall be mounted next to the room temperature sensor.

H. Carbon Monoxide Detectors:

1. Provide carbon monoxide sensing and transmitting equipment with local LED display and 4-20 ma analog output. The unit shall sense and transmit carbon monoxide readings from 0 to 200 ppm linear. Provide solid-state sensing element. Input voltage to the unit shall be 24 VDC. Provide aspirated enclosure for duct mounting. Approved manufacturer and model: Kele model WCO or approved equal.

2. Provide individual indicators and contactors for each level, initially calibrated for 50 ppm and 100 ppm.

3. Maximum response time to 100 ppm CO calibration gas shall be two minutes.

4. Provide with one field calibration kit equal to RE Tech CM-FCK/.

I. Building Power Monitoring: Connect wiring to electrical disconnect, external to electrical gear. Disconnect and wiring to electrical gear shall be provided by Electrical Contractor. Approved manufacturer and model: Kele model 258 or approved equal.

J. Water/Flood Detector: Kele model WD-1B or approved equal.

K. Liquid Level Sensors

1. Enclosed and Open Pit Sumps: Float type switch suitable for fluid in which immersed. Switch shall be assembly mounted, designed, and located for ease of maintenance access, removal, and level adjustment.

2. Liquid Tanks: Float type switch suitable for fluid in which immersed. Switch shall be assembly mounted, designed, and located for ease of maintenance access, removal, and level adjustment. When tank control package is equipped with local alarm, connect remote alarm indication into local alarm circuit. Provide interposing relay as required.

3. Steam Condensate Receiver Tanks: Float type switch suitable for steam condensate. Coordinate location of tee into receiver vent pipe for sensor location. When receiver control package is equipped with local alarm, connect remote alarm indication into local alarm circuit. Provide interposing relay as required.

L. Building Utility Meters: Connect to Utilities Department PLC and BAS system.

1. Chilled Water BTU meters
   a. Rosemount magnetic flow meter, model 8705 FSA xxx C1 W0 N0 flow tube, with 8712E S R 2 A 1 N0 DA1 M4 remote transmitter, or approved equal.
   b. Flow tube shall be sized to operate within a velocity range of 2-15 ft/sec.
   c. Differential temperature shall use Rosemount transmitter, model 3144P D1 A 2 NA B4 M5 C2 U5 (calibrated range of -5˚F to 50˚F), with matched pair of RTD temperature sensors, Rosemount 0068 P 21 C 30 A xxx T22 V1, or approved equal on supply and return pipes.
   d. Provide an electrical enclosure and power supply according to University of Texas at Austin Utilities and Energy Management Department drawing MD0502A entitled “Utilities Chilled Water Meter Power Supply and Analog Output Wiring Diagram.” The power supply will provide 24 VDC power to the flow and temperature transmitters. The Owner will connect the analog outputs to Utilities and Energy Management Department monitoring devices.

. 2. Domestic water meters
   a. Sensus turbine meter, model W-1000 DR, or approved equal, with impulse contactor register.
   b. Sensus Omni C2 compound turbine meters, with ACT Pak 703NP-1, 24VDC, or approved equal, shall be used for 2”-6” applications.
   c. Local display with volumetric rate and totalizer.
   d. Output shall be scaled pulse transmitter for flow rate.
   e. Water meter strainers of AWWA type shall be used.

3. Cooling or Heating Water Flow Sub Meters - Approved manufacturers and models: Onicon F-3000 series (electromagnetic), Onicon F-4200 Series (ultrasonic clamp-on), Panametric AT868 (ultrasonic clamp-on).

M. Alarms from other building equipment. Connect to BAS system. Inputs may be via DI from other equipment. BAS to display accordingly and provide alarms of events.
1. Fire Alarm Panel Status
2. Fire Alarm Trouble
3. Elevator Status
4. Elevator Alarm

2.15 FAN SAFETIES

A. Fan safeties shall be hardwired in series to the motor starter circuit, or the run enabled circuit if a VFD is provided for the motor with auxiliary contacts to provide individual alarm indication to BAS. Safeties shall be enabled at all times, whether the AHU is in automatic or manual control. The AHU shall not be started without all safeties in place and operational. Combine these safety switches into a single Functional Devices Inc. RIBLB-6 combination relay with local indication and BAS inputs to provide a single motor starter circuit interrupt switch.

1. High temperature safety: Four-wire, two-circuit temperature control, manual reset. Approved manufacturer and model: Johnson Controls model A70KA-1C or approved equal.

2. Low temperature safety: Four-wire, two-circuit temperature control, manual reset. Install at inlet air side of cooling coil, within 12” of coil. Approved manufacturer and model: Johnson Controls model A70HA-1C or approved equal.

3. High pressure safety: Compact low differential pressure switch, manual reset. Approved manufacturer and model: Dwyer series 1900-5MR or approved equal.

4. Low pressure safety: Compact low differential pressure switch, manual reset. Approved manufacturer and model: Dwyer series 1900-5MR or approved equal.

B. Smoke detection safeties are provided by others and are integrated into the fan safeties through fire alarm shutdown relays.

1. The Controls Contractor shall provide shutdown relay and wiring from relay to fan safety circuit.

2. Fire alarm system shall provide one “Fire Alert” input to the BAS to indicate when any air handler is de-energized by the fire alarm system by any smoke detector in the building.

C. Sequence Priorities when deviating from Standard Operation (Supply Fan Control)
1. Safety (Smoke Detectors)
2. Health (C02 sensors)
3. IAQ (%RH)
4. Energy Conservation (Economizer)

2.16 OUTPUT DEVICES

A. Each output shall be its own physically and programmatically discrete entity. The use of multiplexers is not acceptable.

B. Relays, Contactors: All digital outputs shall be electrically isolated from the digital controller by interface relays. Field relays shall have a minimum life of 500K cycles without failure. Provide interface relays with 24 VDC or 24 VAC coils and light integral with relay that indicates when coil is energized. Equipment control circuit shall be wired through a normally closed contact of the interface relay such that upon digital controller failure the equipment shall continue to operate. Coils shall be equipped with transient suppression devices.

C. Electric/Pneumatic Transducers: For interface with pneumatic actuators provide Kele Model UCP-722, or ACI Model EPC series, universal electronic/pneumatic transducers. Provide with manual output adjustment and pressure display. Transducer shall be calibrated to accept a 0-10 VDC input from the controller. Set the tracking ratio at 1 volt = 2 psi, so that 0-10 VDC input results in 0-20 psig output. The controller output conversion for each respective output shall indicate the actual voltage required for 0% and 100%. For example on a normally closed pneumatically operated valve with an 8-13 psig spring range, the conversion at 0% open shall be 4 VDC at 8 psig and at 100% shall be 6.5 VDC at 13 psig.

D. Solenoid valves: Electric solenoid operated pneumatic valves (EPs) shall have a three port operation: common, normally open, and normally closed. They shall be rated for 50 psig when used for 25 psig or less applications, or rated for 150 psig when used for 100 psig or less applications. The coils shall be equipped with transient suppression devices to limit transients to 150 percent of the rated coil voltage. Where EP is actuated directly by a BAS controller, coil voltage shall be 24 VDC or VAC 9 watts maximum and shall tie directly into BAS outputs without an interface relay. Solenoid shall be located inside field interface panel. Approved manufacturer and model; Johnson Controls V-11 or approved equal.

E. Variable Frequency Drives: Provide low voltage wiring between the Variable Frequency Drive and DDC controller to provide Start/Stop, Output Speed, Feedback Speed, KW, and Fault. If a protocol chip is available in the VFD, it is acceptable to provide the required information and additional information through network connection, but Start/Stop and Output Speed must be hard-wired, as a minimum requirement.

2.17 CONTROL VALVES

A. Major Equipment applications.

1. Provide characterized v-ball control valves for chilled water, hot water, and steam for all air handler and other major equipment control applications. Water valves shall be sized by the control manufacturer to produce the required design flow rate at a pressure loss of 5 psig at full open, with an actual pressure loss not exceeding 5 psig. Steam valves shall be sized to produce the required design flow rate at a pressure loss of 12 psig at full open, and actual not higher than 12 psig.

2. When flow requirements exceed capacity of 1 control valve, provide 2 control valves, piped in parallel and sized for 1/3 and 2/3 capacity.

3. With 2 control valves, modulate the 1/3 control valve to the 50% open position, sequence the 2/3 control valve when the 1/3 control valve is at 50% position, and modulate the 2/3 control valve at a faster rate than the 1/3 control valve as the load increases so that they both reach full open position at the same time. On a decrease in load, the 1/3 and 2/3 control valves shall modulate in the reverse sequence.

4. Approved manufacturers: Valve Solutions, Inc. Series V-port High Performance Ball Valve, Belimo B2, B3, B6, VB, VSS Series, and A-T Controls Triac “V” series.

5. Valve Construction:

   a. Type: Characterized V-Ball, two port
   b. ANSI Class: 150/300 multi-rated
   c. Body: Carbon Steel, bronze, or brass.
   d. Ball: Stainless steel

e. Ball Seal: Low friction carbon/graphite, and appropriate for media and service temperature.
f. Connections: Female NPT or flanged
g. Stem: Stainless steel
h. Stem Seals: EPDM o-rings
i. Angle of Ball Rotation: 0 – 90 degrees
j. Media Temperature: minimum 30-50˚F Chilled Water; minimum 300˚F Steam
k. Minimum Turndown: 300:1

6. Additional Requirements:

a. Equal percentage flow control, unless otherwise scheduled or noted.
b. Universal non-condensing mounting plate with thermal barrier between actuator and mounting plate to accommodate different size actuators.
c. Extended valve stem for actuator mounting plate to be located outside of pipe insulation.
d. Manual override of valve actuator.
e. Provide pipe unions and gate type isolation valves, or two-piece ball valves, in pipe on both sides of valve to facilitate change out of valve.
f. Provide pressure gauges up and downstream of valve located between the isolation valves and valve inlet/outlet. Provide stainless steel nipples with isolation valves for gauge taps.

B. Terminal Equipment applications

1. Provide characterized v-ball control valves for all terminal equipment, such as VAV boxes, and other small equipment control applications. Provide valves and actuators rated for chilled water, hot water or steam to match the application.

2 Approved manufacturers: Belimo B2 series and VSI series E.

3. Valve Construction:

a. Type: Characterized V-Ball, two port
b. ANSI Class: 150/300 multi-rated
c. Body: Bronze, brass or stainless steel
d. Ball: Stainless steel
e. Seat: PTFE
f. Connections: Female NPT
g. Stem: Stainless steel
h. Stem Seals: EPDM o-rings
i. Angle of Ball Rotation: 0 – 90 degrees
j. Media Temperature: 0˚F to 212˚F
k. Minimum Turndown: 300:1

4. Additional Requirements:

a. Equal percentage flow control, unless otherwise scheduled or noted.
b. Universal non-condensing mounting plate with thermal barrier between actuator and mounting plate to accommodate different size actuators.
c. Extended valve stem for actuator mounting plate to be located outside of pipe insulation.
e. Provide pipe unions and gate type isolation valves, or two-piece ball valves, in pipe on both sides of valve to facilitate change out of valve.

f. Provide pressure gauges up and downstream of valve located between the isolation valves and valve inlet/outlet. Provide stainless steel nipples with isolation valves for gauge taps.

C. Butterfly Valves

1. Actuated 2-position isolation valves that are 4" diameter and larger shall be high performance butterfly type with PTFE or Monel seat, bronze or stainless steel disc, bubble-tight, lug-type, and gear operated. Approved manufacturer: Valve Solution, Inc. Flowserve or approved equal.

2. Provide line-size modulating butterfly control valve on incoming chilled water supply line to building to prevent over-pressurization of the building chilled water piping. If secondary pumps in building are not operating and the differential pressure is above setpoint, this valve will limit pressure in the piping.

3. Butterfly valves shall not be used for air handler control valves.

2.18 VALVE ACTUATORS

A. Actuator Selection: Size each actuator for the specific application. All digital control applications shall use electric actuators suitable for the application (chilled water, hot water, or steam). All electric actuators associated with the digital control system shall be of the same manufacturer throughout the project, except for 120 volt actuators required for high torque applications. Stacking two actuators to meet torque requirements is acceptable, when torque requirement exceeds rated torque for listed actuators.

B. Major equipment applications: Use 24 VAC power and a 0/2-10 VDC control signal. Each actuator shall have a maximum run time of 150 seconds and spring return time of less than 60 seconds and shall utilize brushless motor. Actuator shall be adjustable for reversing rotation without dismounting. Approved manufacturers and models: Belimo F or K series, or Promation/ Schischek Inc. D4/D5.S Series.

C. Terminal equipment applications: Use 24 VAC power and 0/2-10 VDC or floating point control signal, spring return or non-spring return, actuator. Actuator shall have a maximum run time of 150 seconds and spring return time of less than 60 seconds and shall utilize brushless motor. Actuator shall be adjustable for reversing rotation without dismounting. Approved manufacturer and model: Belimo or approved equal.

D. High torque applications: Use 120 VAC power and 2-10 VDC control signal, non-spring return, metal housing. Actuator shall have a minimum torque of 347 in-lb. with maximum run time of 25 seconds. Actuator shall be adjustable for reversing rotation without dismounting. Provide manual override of actuator. Approved manufacturers and models: Valve Solutions, Inc., Series 1000 and Promation/Schischek Inc. D4/D5.S Series.

E. Fail Positions: Unless otherwise specified, the fail (normal) positions for AHU automatic control valves shall be as follows: Preheat Coils – NO, Cooling Coils – NO, Heating Coils, NC.

F. General: Mount all actuators according to the manufacturer's instructions and such that the valve position indicator is easily visible and accessible from the floor.

2.19 DAMPER ACTUATORS

A. Actuator Selection

1. Size each actuator for the specific application.

2. Electric Actuator: All digital control applications shall use electric actuators. All electric actuators associated with the digital control system shall be of the same manufacturer throughout the project, except for lab and vivarium supply and exhaust venture valves, terminal unit damper actuators, and smoke control damper actuators. Provide a spring return if a fail position is required.

3. Pneumatic Actuator: only used for small renovation applications where existing control system is to remain pneumatic or other specific applications as directed by the Project Manager. See Pneumatic Controls specification for requirements.

4. Tristate (floating point) electric actuators requiring 2 digital output points are acceptable if a flow sensor is included. This allows verification of the commanded damper position.

B. Non-Laboratory Electric Actuators: 24 VAC power and 0/2-10 VDC control signal or floating point signal if an airflow monitoring device is included. Actuator shall have a maximum run time of 150 seconds and spring return time of less than 60 seconds and shall utilize brushless motor. Actuator shall be adjustable for reversing rotation without dismounting. Approved manufacturer: Belimo or approved equal.

C. Integral actuators on a VAV controller: Actuator shall have a maximum run time of 180 seconds. Provide spring return if a fail open or a fail closed position is needed. Provide manual clutch override with push-button release. Approved manufacturers: Siemens and TAC.

D. High speed isolation damper actuators: 24 or 120 VAC power, On/Off 2-position control, non-spring return, direct coupled, metal housing. Actuator shall have a maximum run time of 7 seconds in both directions. Provide visual position indicator and manual push button override. Approved manufacturer and model: Belimo or approved equal.

E. Fail Positions: Unless otherwise specified, the fail (normal) positions for AHU automatic control dampers shall be as follows: Outside Air – NC, Return Air – NO, Relief Air – NC.

2.20 AUTOMATIC CONTROL DAMPERS (other than smoke dampers)

A. All control dampers shall be of the opposed blade type. Parallel blade control dampers are not acceptable. Dampers 16 square feet and smaller shall be constructed in a single section. Dampers larger than 16 square feet shall be constructed in multiple sections with each section driven independently by a separate damper actuator. Cross-linking damper sections over damper sectional mullions or other obstructions is not acceptable.

B. Performance: Test in accordance with AMCA 500

C. Frames: 13-gauge galvanized steel formed into channels and welded with corner reinforcement.

D. Blades: Provide blades of double-piece 22-gauge galvanized sheet steel spot welded together for extra strength to withstand high velocities and static pressures. Blades shall be constructed to assure non-slip pivoting of the blades when a damper is used as a single module or is interconnected with others. Blade height shall be in 6” increments. Maximum blade width shall be 48”. Blades shall be attached to minimum ½” keyed shafts with set-

screws. End of keyed shaft shall indicate position of damper blades such that mark on end of shaft is parallel with blades.

E. Blade Seals: Neoprene mechanically attached, field replaceable on two edges.

F. Jamb Seals: Spring stainless steel.

G. Linkage Bearings: Oil impregnated sintered bronze.

H. Leakage: Dampers shall be designed so that the maximum leakage shall be 4 CFM per square foot of damper with 4" water gauge pressure differential. Submit leakage test data with shop drawings.

I. Maximum Pressure Differential: 6" water gauge.

J. Temperature Limits: -40˚ to 200˚F.

K. Approved manufacturers and models: Johnson Controls, Model D-1320 -- VOPEN, Nailor Model 1120, Ruskin Model CD-60, and Tamco Series 1000, or approved equal meeting the requirements of this section.

2.21 ROUND CONTROL DAMPERS (< 20"D)

A. Performance: Test in accordance with AMCA 500.

B. Frame: 10" wide, 16-gauge galvanized steel with 14-gauge actuator mount. Actuator mount shall be of sufficient dimensions to mount actuator being used.

C. Blade: 16-gauge galvanized steel.

D. Shaft: 1/2" diameter plated steel with clearly marked blade position indicator. Crank arm shall be 45 degrees off damper centerline when full open or closed.

E. Bearings: Sintered bronze.

F. Blade Stop: 10-gauge galvanized steel rolled flatbar.

G. Approved manufacturers and models: Nailor Hart 1091UT, Arrow 70UT, and Ruskin.

H. For dampers > 20" use Ruskin CDRS25 or approved equal.

2.22 COMBINATION SMOKE/CONTROL DAMPERS

A. All combination smoke/control dampers shall be UL Listed as an assembly and shall be electrically operated. A signal from the smoke management system shall open or close smoke dampers. Relays for damper actuation shall be located in the air handler mechanical room that serves the respective smoke control zone and shall be located adjacent to the smoke management relay interface panel. Approved smoke control damper: Ruskin SD-60 with Honeywell or Belimo electric actuator, or approved equal.

B. Mixing lateral dampers used in conjunction with Smoke Management System: Mixing lateral damper control shall be overridden by the smoke management system. See the Smoke Management System sequence of operation for the required mixing lateral damper control sequence.

C. Combination smoke/control dampers shall be sequenced in accordance with the smoke management system and coordinated with BAS sequence of operation.

2.23 WIRING AND CONDUIT

A. All wire shall be copper and meet the minimum wire size and insulation type listed below:

Wire/Cable Type	A Wire Size	Insulation Type	Maximum Capacitance	Typical Voltage
Power	#12	600 Volt		120 AC and above
Class 1	#14	600 Volt		120 AC and below
Class 2	#18	300 Volt, overall shield		24 DC and below
Communications	#24	300 Volt, overall shield	12.5 pf/ft	24 DC and below
Communications Network		Category 5e cable		

B. Where different wiring types terminate within or pass through the same enclosure, maintain clearances and install barriers per the National Electric Code.

C. Multi-conductor cables, which group independent BAS inputs or outputs, power conductors, communication circuits, etc. wiring into one jacketed sheath, are not acceptable. Each wiring circuit shall be run independently sheathed from other circuits.

D. Provide conduit types as follows:

1. Electric Metallic Tubing (EMT): Concealed in interior finished spaces; exposed in interior unfinished spaces.

2. Rigid Galvanized Metal Conduit: All exterior locations; interior locations subject to moisture.

3. Decorative Surface Metal Raceway: Exposed interior finished spaces.

4. PVC Schedule 80: Exterior where exposed to corrosive atmospheres.

5. Flexible metallic conduit: For transitions from stationery structure or equipment to rotating or moving equipment and for final connections to field devices.

6. Liquid-tight flexible metallic conduit: All exterior locations; interior locations subject to moisture for transitions from stationery structure or equipment to rotating or moving equipment and for final connections to field devices.

E. The minimum conduit size shall be ¾", except room temperature sensor and communication conduit, which may be ½". Use compression or threaded fittings. Watertight compression or screwed fittings shall be used for exterior locations and interior locations subject to moisture. Provide raceway seal-off fitting where exterior raceways enter the building or between areas of high temperature/moisture differential.

F. Flexible metallic conduit, maximum 3-foot length, shall be used for transitions between stationary and non-stationary equipment and/or structure (for example, motors, actuators, air handlers) and for final connections to sensors and control devices mounted on vibration producing equipment. Liquid-tight flexible conduit shall be used in exterior locations and interior locations subject to moisture.

G. Junction boxes shall be provided at all Power and Class 1 wire splices, equipment terminations, and transitions to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

2.24 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: use for all mechanical and plenum space pneumatic control air, neatly routed together and secured parallel to the building walls. ASTM B280, Type K, seamless, hard drawn or annealed. Fittings: ANSI/ASME B16.22, wrought copper. Joints: ANSI/ASME B32, 95-5 or 60-40 tin antimony.

B. Polyethylene Tubing: Used for final connection to device where maximum length is 18". Also used for drops to a pneumatic thermostat inside room walls. Black, flame retardant, virgin polyethylene, conforming to modified ASTM D1693 test. Fittings: UL approved rod or forged brass rated to 200 psig at 100˚F. Joints: Compression or barbed type.

C. All pneumatic tubing shall be minimum 1/4".

D. Tubing routes shall be neat, parallel, parallel or perpendicular to the building walls, and securely mounted.

2.25 COAXIAL CABLE

A. Coaxial cable shall conform to RG62 or RG59 rating.

2.26 FIBER OPTIC CABLE

A. Fiber optic cable shall be Multimode 62.5/125. Only glass fiber is acceptable, no plastic.

B. Fiber optic cable shall only be installed and terminated by an experienced Contractor. The Building Automation System (BAS) Contractor shall submit to the Owner the name of the intended Contractor of the fiber optic cable with his proposal.

C. Maximum single segment loss shall be limited to 10 db.

D. Contractor shall provide a written report to the Owner that indicates the total signal loss and fiber lengths over the network segments installed.

2.27 LABELS

A. Conduit: Provide factory fabricated flexible, semi-rigid plastic preformed markers to fit around conduit. Markers shall have black lettering on an orange background, labeled "Controls", spaced ~ 20 ft. Also, paint each j-box orange.

B. Power, Class 1 and Communication Wiring and Pneumatic Tubing: Fabric wrap type numbered consistent with as-builts.

C. BAS Field Device Wire (Class 2): Neatly typed with permanent ink on plastic label. Label securely fastened around wire and located at an accessible and readable location.

2.28 NAMEPLATES

A. Equipment Areas: Nameplates shall be laminated plastic with engraved white letters on a black background. Minimum lettering height shall be 1/4". Nameplates shall be attached

with rivets or bolts. Adhesive backed nameplates are acceptable where rivet attachment is not practical.

B. Finished and Occupied Spaces: Nameplates shall be laminated plastic with engraved white letters on a black background. Minimum lettering height shall be 1/4". Nameplates shall be attached with rivets. Adhesive backed nameplates are not acceptable.

C. Plastic Laminate: Engraving stock melamine plastic three-layer laminate, 1/16" minimum thick for signs up to 20 square inches, or 8" length; minimum 1/8" thick for larger sizes. Engraved text shall contrast with background.

2.29 ENCLOSURES

A. All controllers shall be mounted in new NEMA 1 rated steel enclosures with baked enamel finish and a hinged, locking cover. Cover shall open fully 180 degrees. Provide hinge pins that allow full removal of cover in areas where door cannot be fully opened.

B. All building exterior and outside mounted enclosures shall meet NEMA-4 ratings.

C. All locks and lock hardware shall be keyed to match the UT Standard configuration—CH751 lock cylinder.

D. Label controls enclosures "HVAC CONTROLS".

PART 3 EXECUTION

3.1 PROJECT MANAGEMENT

A. Provide a Project Manager who shall, as part of his duties, be responsible for the following activities:

1. Coordinate between this Contractor and all other trades, Owner, local authorities and the design team.

2. Scheduling of manpower, material delivery, equipment installation, checkout, and commissioning.

3. Maintenance of construction records such as project scheduling and manpower planning, and AutoCad for project coordination and as-built drawings.

4. Schedule and administer meetings throughout progress of the work at maximum monthly intervals.

5. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two (2) days to Owner, participants, and those affected by decisions made.

3.2 HAZARDOUS MATERIALS

A. For existing buildings, Contractor shall review routing of conduit, wire, tubing, and equipment locations with the Owner prior to beginning of installation. Where routing areas are determined to be suspect of hazardous materials, the Owner will test these areas prior to Contractor entrance. Contractor shall not enter areas suspected of contamination until tests have confirmed they are clean or until abated where found to be contaminated. At

any time during construction the Contractor shall notify Owner immediately if an area scheduled for work is suspected of contamination.

3.3 IDENTIFICATION

A. Install permanent wire labels at each end. Label shall cross-reference exactly with as-built drawings.

B. All field device wiring shall be labeled consistent with that shown on the as-built drawings and shall include the point's name to which the wire connects. Provide a label at the field device and at the terminal strip in the BAS controller enclosure. Label shall be neatly typed and permanent.

C. Label all terminal strips. Terminal strips identification shall match the identification of the wire terminated.

D. Identify all pneumatic tubing with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

E. Conduit: Provide conduit labels inscribed "CONTROLS" at the following locations:

1. Within 3 feet of all BAS enclosures,

2. At 20-foot intervals along conduit runs.

3. All pull and junction box covers shall be painted orange with the cover permanently labeled "CONTROL".

F. Provide nameplates at each BAS controller or group of controllers at the power wire terminal strip inside the enclosure that identifies the name and location (room number and building location) of the building electrical distribution panel where power for the BAS equipment is obtained.

G. All field device and controller enclosures shall be identified with a nameplate. Controller enclosure nameplates shall be engraved "HVAC CONTROLS," shall also identify each controller contained in the enclosure and mechanical equipment monitored or controlled by controllers located inside enclosure. Field Interface Panels nameplates shall be engraved "CONTROLS FIELD DEVICE". Indicate by name or function each control component in the enclosure. Equipment identification shall follow UT Facilities Maintenance standard nomenclature.

H. Label output transducers with the point name of the device controlled and the normal position and spring range of controlled device.

I. Label location of terminal unit controller on exposed side of the ceiling directly below the location of enclosure. Label shall be orange colored, 1/2" diameter round nameplate. Nameplate shall not be engraved with text. Label shall be permanently affixed using liquid nails.

3.4 ELECTRICAL INSTALLATION REQUIREMENTS (DIVISION 26)

A. Install a minimum of 2 independent power circuits for BAS controllers. One circuit shall feed the controllers and panel devices and one circuit shall feed a service convenience outlet. All wiring shall be sized for minimum voltage drop per NEC recommendations.

B. Power for the BAS controllers shall be obtained from one dedicated 120 VAC circuit not serving other building circuits. Power shall be "daisy chained" to each BAS controller in the same mechanical room. Multiple circuits and wire sizes to BAS controllers shall be provided as determined by circuit load and voltage drop calculations. Label the circuit breaker panel circuit “BAS.” Label the BAS Panel with the building power panel and circuit number where the power is sourced.

C. Emergency Power: Where the building has emergency or back-up power serving the HVAC equipment, the circuit feeding the BAS Panel shall also be sourced from the emergency or back-up power source.

D. Splicing or wire nutting of Class 2 and communication wiring is not allowed. The Contractor shall provide continuous point-to-point and device-to-device wiring if possible. If not, communication wire shall terminate on terminal blocks or the terminals of the device it serves.

E. All power wiring for the BAS equipment shall be routed with a dedicated true earth ground by means of wire media. Contractor shall verify continuity of earth ground utilized for BAS equipment and shall ensure its viability for use in the BAS system.

F. Number-code wires appropriately for future identification and servicing of control system.

G. Install systems and materials in accordance with manufacturer’s instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications, except where specifically stated in this section.

H. The term “control wiring” is defined to include providing wire, conduit, and miscellaneous material as required for mounting and connecting electric or electronic control devices.

I. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

J. Provide fused disconnects inside each controller enclosure for each power source that disconnect all power to equipment inside enclosure.

K. Contractor shall review routing of conduit and wire with the Owner prior to beginning of installation.

L. All wiring and cable, located in mechanical rooms and inside walls, shall be in conduit. Wiring or cable tie wrapped to existing structure or equipment supports is not acceptable. Class 2 and communication wiring carrying DC voltages only may be run in cable tray and cable ladder where available. AC voltage carrying conductors shall not use cable trays, ladders or other community type wire management systems.

M. Wall sensors shall be installed in electrical J-boxes and conduit stubbed to above lift-out ceilings. Plastic bushing shall be installed where the sensor wire exits the conduit to prevent damage.

N. UL plenum rated cable for control, signal, and 24VAC power wiring is allowable above accessible lift-out ceilings, in air plenums, and in other areas as approved by local and

NEC codes. Cables shall be supported by cable trays or J-hooks independently attached to structure.

O. Conduit, in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Where wall construction precludes concealed installation and Owner approval is obtained, metallic surface raceway may be used. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

P. All conduits shall be run parallel to or at right angles to the building structure. Conduit shall be independently supported to structure. Conduit attached to piping hangers, equipment hangers and ceiling hangers is not acceptable.

Q. Wire gutters for low voltage wiring shall be located directly above controller enclosures. Gutter width shall be sized to contain the wires enclosed, but as a minimum, shall be the width of the controller enclosure with a height of 6" and depth of 6". Contractor shall provide enough wire length inside the gutter to reach twice the distance to the bottom of the controller enclosure. Provide minimum two 2" conduit nipples between gutter and controller enclosure. Provide additional 2" nipples where wire quantities exceed capacity of base quantity of nipples.

R. Conduit runs shall be kept a minimum of 2 feet from hot water, steam, condensate piping or other heat producing equipment.

S. Install 120V power to each HVAC terminal box and each DDC panel containing a UPS. Install a switch at each terminal box to shut off power to the individual box without shutting off power to other boxes on same circuit. The UPS shall be provided by the Controls Contractor.

T. For each three-phase motor starter furnish an individual control transformer to supply 120 volt control power and auxiliary contacts (one N.O. and one N.C.) for use by this section.

U. Install conduit and back-boxes for all room sensors, including, but not limited to temperature, humidity, motion, occupancy, and CO2 sensors.

V. Connect single output from fire alarm panel to BAS to provide "Fire Panel Alarm" indication and alarm. This alarm is for HVAC equipment shutdowns only, not for all fire panel alarms.

W. Provide a relay in each air handler safety circuit to accept a signal from the fire alarm panel to stop the air handler upon activation of duct smoke detectors. Smoke detectors shall be provided and installed by Electrical Contractor and connected to fire alarm panel. The Electrical Contractor shall provide wiring from the fire alarm panel to the air handler safety circuit relay.

3.5 INSTALLATION PRACTICES - SENSORS

A. The location of sensors shall be guided by the mechanical and architectural drawings. Final sensor locations shall be approved the Owner prior to mounting.

B. Space temperature and humidity sensors shall be mounted a minimum of 24" away from machinery generating heat, direct sunlight and diffuser air streams.

C. Outdoor air sensors shall be mounted just inside a louver where outside air enters the mechanical equipment. Sensor shall be placed at louver so that entering outside air passes over sensor. Install sensors such that effects of heat radiated from the building or sunlight is minimized. Provide radiant sun shields on outdoor sensors.

D. Controls Contractor shall provide thermo-wells appropriate for the sensor being installed and as scheduled on the drawings. Coordinate location of thread-o-lets for use with thermo-wells with Mechanical Contractor. Mechanical Contractor shall provide and install thread-o-lets. Thermo-well mounted sensor shall include thermal conducting compound within the well to ensure good heat transfer to the sensor. A spare well shall be provided at all locations for set-up and calibration. Spare well shall be installed to sense same location is sensed medium as the associated digital sensor.

E. Water and instrument air mounted sensors shall be removable without shutting down the system in which they are installed. Provide ball type isolation valves at taps into main piping. On chilled water systems, use stainless steel ball valve, schedule 20 or heavier type 304 stainless steel pipe and fittings to sensor. Mount sensors where indicated, or if not indicated, mount to structure in accessible location.

F. All sensors shall be mounted in serviceable locations and, where possible, at an elevation where device may be serviced without the use of a ladder. Connecting tubing from the sensing location shall be extended to the transducer location at a serviceable location in the same area. For duct static pressure sensors located above lay-in ceilings and not easily accessible if mounted to duct, locate the transducer on the wall just above the ceiling, and provide piping from the transducer to the tap into the ductwork.

G. For duct static pressure sensors, the duct high-pressure port shall be connected to a metal static pressure probe inserted into and securely fastened to the duct. If not otherwise noted, the reference low-pressure port shall be left open to the plenum area. Where the reference is to atmospheric pressure, tie the reference port to an outdoor pressure reference as detailed.

H. For building interior static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Provide a decorative cover over the sensor probe in finished interior spaces. Pipe the low-pressure port to the outside of the building as detailed.

I. Low and Medium Steam Pressure: Locate transducer at building steam PRV. Tee into same tap provided at PRV for steam gauge downstream of shutoff valve, steam pigtail, and pressure snubber. Where PRV is not equipped with pressure gauge assembly tapped into steam, Contractor shall provide tap into steam PRV at appropriate locations, isolation valve, steam pigtail, pressure snubber, and pressure gauge with transducer.

J. Support instruments and tubing to relieve strain on connections and to prevent excess vibration or movement.

K. Install piping and tubing in a neat appearance, protected from being stepped on, and include provisions for expansion, drainage and without interference to access to valves or other equipment. Tubing bends are to be made with a tool; hand bends are not acceptable.

3.6 INSTALLATION PRACTICES - DAMPERS

A. Dual Duct VAV Boxes or Mixing Laterals

1. Fail position: cold duct open and hot duct closed, except when hot duct also serves as a smoke purge supply. Set actuators such that actuator spring provides fail position. Fail to last position is acceptable for non-spring return actuators on terminal devices, except when hot duct also serves as a smoke purge supply.

2. Normal operation: cold duct and hot duct modulating.

B. Air Handler Mixing

1. Fail positions: Outside air, relief air closed. Return air open. Set actuators such that actuator spring provides fail position.

2. Normal operation: Outside air, relief and return air modulating.

3.7 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Provide UPS power to all major BAS equipment controllers and/or network controllers if better power quality is necessary or if uninterruptible power is needed to safely automatically restart equipment after a normal power loss. Size the UPS to serve the controller(s) for a 20 minute power loss. Connect the UPS alarm contacts to the BAS. Approved manufacturers: APC Smart-UPS series with the Relay I/O SmartSlot Card, and Toshiba 1000 series with the UPS Remote Contact Card.

B. Electrical Contractor to provide wiring to UPS and Controls Contractor to provide wiring from UPS to each controller.

C. Provide naturally ventilated enclosure for UPS. This enclosure shall be in addition to enclosure provided with UPS that houses electronic components. This enclosure shall be separate from BAS controller enclosures. External batteries, where required, shall also be located inside UPS enclosure. Provide nameplate on exterior of enclosure engraved “BAS UPS.”

D. Provide single outlet receptacle inside UPS enclosure for connection of UPS from building power.

E. Provide minimum 4” clearance around outside perimeter of UPS enclosure for natural ventilation.

3.8 ENCLOSURES

A. All controllers inside enclosures and mounted in the field shall be mounted vertically.

B. All BAS controllers shall be mounted in enclosures. This enclosure shall be in addition to any standard enclosure provided with the controller. Multiple controllers may be located in the same enclosure. The enclosure shall be sized for all equipment and appurtenances installed plus 50% clear, unobstructed spare space for future expansion.

C. All tubing and wiring within enclosures shall be run in plastic “panduit” type track or other wire/tubing management system that is securely fastened to the enclosure backplane. Adhesive type mounting clips for tubing and wiring is not acceptable.

D. All tubing shall be connected to enclosures with bulkhead fittings.

E. Panel equipment layout shall provide for location of AC and DC equipment in distinctly separate and isolated sections inside the enclosure.

3.9 ENCLOSURE LOCATIONS

A. Major Equipment Controller Enclosures: Enclosures containing controllers for major equipment shall be located as indicated on the drawings or within line of site of equipment being controlled. Enclosures shall be independently supported to structure. Do not mount enclosures on ductwork, equipment, from pipe or equipment hangers.

B. Terminal Equipment Enclosures

1. Enclosures containing terminal equipment controllers shall be directly mounted onto the terminal device that is served. Where enclosure is mounted above a hard ceiling, coordinate access door locations with other Contractors.

2. Enclosure doors shall open fully 180 degrees for maintenance access. Where door cannot fully open provide enclosure door with pin type hinges such that door can be removed for maintenance access.

C. Coordinate locations for all enclosures with other trades. Ensure sufficient access space at face of enclosure for full opening of enclosure cover, 36" minimum.

3.10 PROJECT REVIEW

A. Project review shall conform to the Field and Workstation milestones listed below. Contractor shall allow for review and coordination with Owner's review within the project time schedule.

B. Minimum 2 weeks prior to Final Review provide hardcopy printout of graphics and as-built point schedules to Owner. Graphics will be reviewed by Owner with mark-ups returned to Contractor for correction. Point schedules will be used in final commissioning and acceptance of the installation.

C. Field Installation Review Milestone Meetings with campus Instrument and Controls Shop

1. Pre-installation Meeting
   a. Project specifications/drawings
   b. Meet project reviewers
   c. Initiate interface with other Contractors

2. Submittal (require 4 copies plus number want returned)
   a. Device types
   b. Proposed installation layout

3. Field Layout (on-site)
   a. Proposed enclosure locations
   b. Controller Power source
   c. Convenience Outlet Power sources
   d. Existing and new field device locations
   e. Verify with other Contractors

4. Rough-in Phase 1 (pre-wire, pre controller)
   a. Conduit workmanship
   b. Field device location verification

5. Rough-in Phase 2 (controllers mounted)
   a. Wiring workmanship
   b. Field wire terminations
   c. Enclosure completeness

6. Final Review, Field and Graphics
   (coordinate with completion of workstation milestones)
   a. Device by device, field to workstation verification
   b. Simulate alarm conditions and verify at workstation

D. Workstation and Programming Review Milestones

1. Initial Coordination
    a. Graphics
        1) Utilizing the list of graphics provided with the project submittal, provide mockups of proposed standard graphic templates and project specific graphics based on Owner's standard graphics.
        2) Provide Full Path Graphic Name and Graphic Description of all graphics for the project. List shall be grouped logically and shall correlate to graphic navigation.
        3) Define project specific graphic acceptance checklist/sign-off document. Provide sign-off columns on list for Contractor and UT Austin system user.
    b. Points
        1) Utilizing the list of points provided with the project submittal, define all inputs, outputs and variables for each controller. List shall include full path point name, point type, and point description. Notate which points are global.
    c. Alarms
        1) Utilizing the list of alarms provided with the project submittal, provide an expanded list to include full path name, point type, point description, alarm name, alarm routing (workstation names), alarm limit variable names and alarm limit variable values.
    d. Equipment and Building Schedules
        1) Provide a list of equipment and zones and their anticipated HVAC operating schedules. List shall include full path schedule name, full path occupancy variable name, schedule description and scheduled occupied/unoccupied times.
    e. Additional Programming
        i. Provide a list of control Output fail-safe positions/values.
        ii. Propose the HVAC equipment restart sequence with applicable staging delays.

2. Graphic Development
    a. Throughout project as graphics are developed, they shall be presented to the Owner for approval. All graphics shall be finalized and approved by the Owner prior to control commissioning.
    b. Graphics will be reviewed for conformance to Owner's standard graphics, content, data grouping, menus, navigation and miscellaneous object links.

3. Control Algorithms
    a. Reference Digital Control Commissioning guidelines

4. Alarms
    a. Verify that all points designated to have alarms as detailed by alarm report provided under Workstation Alarms have correct alarm limits programmed, that each alarm condition has been field simulated and verified on the finalized graphics. Reporting to finalized graphic shall include correct red navigation notification.
    b. Verify that critical alarms report to active alarm window.
    c. Verify that alarm reports via the alarm report workstation function correctly.
    d. Verify that all alarms are associated with the correct alarm event notification and are enrolled correctly.

5. Final Review, Field and Graphics
    a. Final graphics—all Owner punch-list items completed and all applicable signatures on Graphic Acceptance Checklist
    b. Alarms attached, tested and documentation of alarms reported to workstation provided to Owner.

c. Schedules installed and functioning.
d. Device by device, field to workstation commissioning.
e. Field simulation of alarm conditions and verified at workstation.
f. Control loops and bump tests documented.

3.11 DIGITAL CONTROL COMMISSIONING

A. The Controls Contractor shall perform operation and acceptance tests on the control loops and alarms for all systems.

B. The Controls Contractor shall coordinate with the UT I&C Shop Supervisor in advance so that UT I&C technicians can accompany the Contractor to witness/verify each controls device's performance and control sequence in the field and at the front end BAS workstation. This verification should happen only after the Contractor has himself tested and repaired (if needed) the performance of each device and control sequence.

C. The Contractor shall allow time in project schedule for control commissioning as follows:

1. One system's controls shall be initiated at a time (i.e. air handler, pump, etc.).

2. One week prior to DDC commissioning, provide 2 copies each of hardcopy printout of each system's control algorithms, and interim as-built point list with correct nomenclature. Workstation graphics, system alarms, and time schedules shall also be complete. Point list shall include verification sign-off and date of sign-off lines for each point. The release of this information to the Owner shall provide notification that the installation is ready for review and comment.

3. Prior to initiation of next system, all verification of the current system being initiated shall be complete. Completion shall include a 24 hour historical trend log as well as loop tuning trending showing stable control, successful bump tests, and field to workstation, end to end verification of each point including but not limited to temperatures, pressures, status, and start/stop control. Verification shall include Owner's review of field tests and real-time and off-line review of trend logs.

4. Once all of each building's systems are under digital control, sequentially perform "bump tests" on each controlled component of each system as proof of overall building system control stability. A copy of a 24-hour trend log of all process variables shall be submitted to document performance at completion of testing. Re-tune control loops where trending indicates instability, re-trend and re-verify.

5. Bump tests shall consist of one or more simulated system upsets as follows: setpoint increase/decrease, flow variation, system shutdown and startup and as otherwise determined. For each test, submit a trend (log or graphic printout) beginning 1 minute before the bump and continuing past re-stabilization for at least the stabilizing interval. Bump the control variable by an interval at least equal to the greatest step that may be expected in operation.

6. Interrelated process variables shall be grouped onto the same trend log for comparison (for example, cold deck temperatures grouped with building chilled water flow, space temperatures grouped with cold/hot deck temperatures). Contractor shall provide proposed grouping of process variables with the submittal. Trend logs verifying all building systems shall be produced over identical time intervals.

7. Ensure that all alarms have been commissioned as detailed under Workstation and Programming Review Milestones.

8. Digital Control Completion: Complete modifications to workstation graphics and alarms as required by review comments. Provide hardcopy of final point schedules, process variable control setpoints and alarm setpoints.

C. Hardcopy documentation of testing showing controllability shall be forwarded to the Owner for final approval of system operation.

D. Commissioning Functional Test Reports

1. Controls Contractor shall review and submit proposed modifications and additions to the Owner provided functional test report/checklist for each system, subsystem, or equipment, including interfaces and interlocks.

2. If project specific functional test reports/checklists are not provided by the Owner, the Controls Contractor shall develop and submit project specific functional test report/checklist for each system, subsystem, or equipment, including interfaces and interlocks, and include a separate entry, with space for comments for each item to be tested.

3. The functional test report/checklist shall include operating the system and components through each of the written sequence of operation, for all modes of operation for each identified sequence, including but not limited to startup, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure, CO2 purge, CO purge, economizer, security alarm when impacted, and interlocks with other systems or equipment, as applicable.

4. The test report/checklist shall be formatted in an action-response format with a Yes/No checkbox to allow clearly marking whether or not the identified anticipated response for each applicable control device and monitored point was achieved.

5. The format of each report/checklist shall be tabular, including step-by-step procedures so that the test is clear, sequential, and repeatable with a single line entry for each specific action and a single line entry for each applicable response, both hardware/device related and soft responses, e.g. alarms, trends, setpoint changes, etc.

6. The requirements stipulated in this section are in accordance with Section 01 91 00 – General Commissioning Requirements, and provide requirements for the Controls Contractor.

3.12 SITE ACCEPTANCE TEST (SAT)

A. The SAT procedure shall provide step-by-step instructions and data sheets for test personnel to follow and complete while testing the system. The inputs and outputs shall be field initiated and observed, not simulated.

B. The SAT shall test the system hardware and software including:

1. Input/Outputs
2. Display Screens
3. Field Controllers and control loop tuning
4. I/O Database Verification
5. Network Connections and I/O Wiring Terminations
6. Data throughput
7. System sequence of operations

8. System response times
9. System Failure modes/Self Diagnostics
10. System interfaces with third party equipment
11. System Security
12. System Web Access
13. Data trending (real time and historical) and reports
14. Simulate addition of field devices, logic program changes, generation of custom graphics and reports

C. Final performance testing shall confirm the following:

1. Maximum overshoot of 20%
2. Achieve stability in 5 minutes or less depending on system control sequences
3. Initial response of 20% command within 1 minute
4. Anti-hunting/minimum cycling of control loop

D. A test report shall be submitted upon completion of testing activities.

3.13 PROJECT-SPECIFIC TRAINING

A. The Contractor shall train Owner-designated technicians in each of two sessions. One session shall be in the field training for each installed controller and controls device. The other session shall consist of front end workstation training designed for system operators and administrators, which shall cover the new BAS graphics, their operation (alarm processing, equipment on/off, auto/manual, data trending, etc.), and sequences of operation. Provide printed training material for each student which outlines and summarizes the training content.

B. The training session dates shall be coordinated between the Contractor and the UT Project Manager. Training shall be held after system startup and testing, but prior to final acceptance.

C. If requested, the Contractor shall provide pricing for base bid factory training as a separate line item on the project proposal. Base bid factory training includes instruction by a direct factory representative not by the local installing vendor or Contractor and usually at a factory selected, off-site location. Training cost shall include only the cost of instruction. Do not include transportation, room and board costs. Pricing shall be presented as 1) on per person basis for the following trades: field controls technician, control logic programmer, front end software engineer, network engineer and 2) where group discounts are available, as a group of 4 trainees for field controls technicians.

D. Factory training shall be accomplished using a network of working controllers that are representative of installed hardware.

E. Factory training shall enable students to accomplish the following objectives:

1. Proficiently operate the system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system

7. Access graphics, point reports, and logs
8. Adjust and change system setpoints, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Operate portable operator's terminals
14. Create and change system graphics
15. Create, delete, and modify alarms, including configuring alarm reactions
16. Create, delete, and modify point trend logs (graphs) and multipoint trend graphs
17. Configure and run reports
18. Add, remove, and modify system's physical points
19. Create, modify, and delete application programming
20. Add operator interface stations
21. Add a new controller to system
22. Download firmware and advanced applications programming to a controller
23. Configure and calibrate I/O points
24. Maintain software and prepare backups
25. Interface with job-specific, third-party operator software
26. Add new users and understand password security procedures

F. Factory Training Presentations of objectives shall be divided into three sessions (1- 13, 14-23, and 24-26 above). Participants will attend one or more of sessions, depending on knowledge level required.

1. Day-to-day Operators (objectives 1-13)
2. Advanced Operators (objectives 1-13 and 14-23)
3. System Managers and Administrators (objectives 1-13 and 24- 26)
4. System Administrator (objectives 1-26)

3.14 COMPREHENSIVE TRAINING ALTERNATE

A. Upon Owner request, in addition to the training required in paragraph 3.13, provide a quote for comprehensive automation system training as a separate alternate line item on the proposal for comprehensive automation system training.

B. Training syllabus, approximate class sizes and scope shall include:

1. Field Technician DDC Training--24 students; class size 4.
   a. Overview of direct digital controls
   b. Comparison with pneumatic controls
   c. Digital controllers
   d. Analog Inputs and Outputs
   e. Digital Inputs and Outputs
   f. Input and Output resolution
   g. Electric to pneumatic transducers
   h. Methods of local override control
   i. Methods of remote override control
   j. Hands on troubleshooting
   k. Control programming
   l. Control loop tuning; PID constants and access to constants

m. Verification of accurate loop tuning and control
n. Historical trending, analysis and diagnostics
o. Equipment scheduling
p. System architecture
q. User interfaces
r. Use of user interface software and graphics
s. Grounding
t. Installation practices
u. Troubleshooting techniques and practices--controllers and network

2. General Programming and Control Logic--4 students; class size 2
   a. Introduction to programming applications
   b. Creating/editing/evaluating/debugging control programs
   c. Creating subroutines
   d. Program modeling for consistency
   e. Debugging/troubleshooting/optimizing techniques
   f. Transfer of data between applications--DDE, OPC, etc.
   g. Graphical User Interface: creating, editing, deleting, active graphics

3. Application Configuration & Network Administration-4 students, class size 2.
   a. Overview of system architecture
   b. Overview of workstation and system navigation
   c. Configuring system network and application specific controllers
   d. System expansion techniques/requirements/limitations
   e. System and network security, passwords, user access
   f. Alarms--system and field
   g. Schedules
   h. Groups: creating, editing, deleting
   i. Reports: creating, editing, deleting system and controller reports

C. Contractor shall provide all training personnel, hardware, software, training aids etc. for complete turnkey training. Training shall be held on-site at the Owner's designated class locations. One set of training documents shall be provided for each student. Training shall be tailored to the Owner's specific installation.

3.15 DELIVERY OF EQUIPMENT

A. The Controls Contractor shall deliver equipment to the Project Site, or as otherwise directed by the Owner. The Controls Contractor shall provide recommendations and guidance pertaining to the safe handling, installation, and protection of all equipment items.

3.16 FINAL PROJECT ACCEPTANCE

A. Final acceptance shall occur when the following conditions have been met and acknowledged in writing by the Owner:

1. Testing has been completed and verified by the Owner.
2. Training has been completed.
3. Operation and maintenance manuals and as-builts have been delivered to the Owner.
4. Field mounted schematic record drawings and point lists have been installed.
5. Warranty documentation has been delivered to the Owner.

END OF SECTION

SECTION 23 20 00 – HVAC PUMPS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED

A. Base mounted pumps

1.3 RELATED WORK

A. Section 23 05 13 – Motors

B. Section 23 05 16 – Expansion Compensation

C. Section 21 05 48 - Vibration Isolation

D. Section 23 07 19 - Piping Insulation

E. Section 23 07 16 - Equipment Insulation

F. Section 23 21 00 - Hydronic Piping

G. Section 23 06 20.13 - Hydronic Specialties

H. Section 26 29 23 – Variable Speed Drives

1.4 REFERENCES

A. ANSI/UL 778 - Motor Operated Water Pumps

1.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.

B. Alignment: Base mounted pumps shall be aligned by qualified millwright and alignment certified.

1.6 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

1.9 EXTRA PARTS

A. Provide one extra set of mechanical seals for pumps under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Armstrong

B. Aurora

C. Grundfos

D. Substitutions: Under provisions of Section 23 00 00

2.2 HIGH TEMPERATURE PUMPS:

A. Furnish and install a high temperature hot water pump with performance characteristics as scheduled on the Drawings. The pump shall be designed for a maximum working temperature of 500 degrees F. when the suction pressure plus differential pressure is 420 psi or less and shall have the following construction: casing - ductile iron, impeller - ductile iron, gland - ductile iron, channel rings - cast iron, shaft - AISI-C-1045 steel, and shaft sleeve - 400c hardened stainless steel.

B. The pump shall be equipped with vacuum degassed ball bearings. The outboard thrust bearing shall be a double row deep groove angular bearing. The inboard is a single row deep groove bearing. The bearing shall be designed to give less than .001" (one thousandth inch) end play and a maximum of .002" (two thousandths inch) deflection at the mechanical seal faces. The bearing shall be oil lubricated and be equipped with constant level oiler with a clear PMMA oil reservoir to indicate oil reserve.

C. Pump shaft seal: Seals shall be mechanical. Mechanical seals shall be John Crane Type "1" or approved equal with stainless steel spring and metal parts, ethylene propylene elastomer bellows and solid tungsten carbide sealing face. The seal shall have a minimum life of 8000 hours when the pump is operating at 150 psig suction and 300 degrees F.

D. The pump shall be equipped with water cooled stuffing box. The water cooled stuffing box shall be so constructed that it can be supplied with low pressure cooling water which shall circulate around seal housing and then to drain.

E. The pump shall be mounted on a rigid steel baseplate which is equipped with a tapered drip basin with l" (one inch) pipe tap. The pump shall have a centerline mounted casing to insure proper alignment and allows for expansion all directions from the horizontal centerline of the shaft. The

pump shall be coupled to the motor with a Rexnord Thomas flexible disk coupling with a spacer and extended hubs, Type DBZ-C, of the proper size and with coupling guard, or approved equal.

F. The pump shall be an Aurora Pump Company Model 154 "Apco Chem" peripheral turbine pump or approved equal.

2.3 END SUCTION PUMPS:

A. Furnish and install chilled water pumps of the capacities and efficiencies shown on the Drawings. These pumps shall be selected to be nonoverloading over the entire pump curve range, and shall be further selected such that the selected impeller size does not exceed 90% of the maximum impeller diameter catalogued.

B. The pump casing shall be cast iron. The casing shall be of end suction design with tangential discharge outlet. The casing shall have tapped and plugged holes from priming and draining.

C. Both suction and discharge nozzles shall be provided with appropriate flanges by means of which the proper piping systems may be attached to the pumps. These flanges shall be dimensioned, faced, drilled, and spot faced to conform with the latest American Flange Standard.

D. The impeller shall be of the enclosed type and shall be investment cast. It shall be finished all over. The exterior shall be turned and the interior shall be finished smooth and clear of all burrs, trimmings, and irregularities. The impeller shall be dynamically balanced. The impeller shall be keyed to the shaft and fastened with a washer, gasket, and capscrew.

E. The seal plate and motor bracket shall be of a two piece design, and shall provide an adequate area for internal recirculation of the pumped fluid around the sealing medium.

F. Mechanical seals shall be John Crane Type "1" or approved equal with stainless steel spring and metal parts, ethylene propylene elastomer bellows and solid tungsten carbide sealing face. The seal shall have a minimum life of 8000 hours when the pump is operating at 150 psig suction and 300 degrees F.

G. The impeller shall be direct-coupled to the motor shaft. The motor shaft shall be machined to provide a keyway, and drilled and tapped to accept the impeller fastener. Stub shafts are not acceptable. The outboard shaft extension shall be machined with a keyway to accept a coupling to the driving unit. Lip seals shall be furnished on both the inboard and outboard shaft extensions, and a water slinger shall be furnished on the inboard shaft extension closest to the mechanical seal.

H. The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an O-ring, and shall be positively driven to the keyway by a pin. The use of adhesive compounds to fasten the sleeve to the shaft seal is not acceptable.

I. The power frame shall house a single-row outboard regreaseable thrust bearing. Bearings shall be selected for a 3 year minimum life at maximum load. The outboard bearing shall be locked in place by a retaining ring. The inboard bearing shall not be locked in order to accommodate thermal expansion of the shaft. Lubrication fittings shall be provided in a convenient location. A bearing cartridge end cap shall be provided on the outboard side of the power frame to allow inspection of the thrust bearing without the need for disassembling the power frame housing.

J. The pump and motor shall be mounted on a groutable formed steel baseplate or a drip-rim baseplate with integral drip channels incorporated on each side. Each channel shall include an NPT drain connection and plug. Each channel shall include an NPT drain connection and plug. The base shall be sufficiently rigid to support the pump and the motor without the use of additional supports or members. See Drawings for construction details of pump base.

K. Each pump shall be coupled to the motor with a Rexnord Thomas flexible disk coupling with a spacer and extended hubs, Type DBZ-C, of the proper size and with coupling guard, or approved equal.

2.4 HORIZONTAL SPLIT CASE PUMPS:

A. Furnish and install chilled water pumps of the capacities and efficiencies shown on the Drawings. These pumps shall be selected to be nonoverloading over the entire pump curve range, and shall be further selected such that the selected impeller size does not exceed 90% of the maximum impeller diameter catalogued.

B. The pump casings shall be cast iron members. They shall be split at the horizontal centerline of the shaft in each case. The flanges of the upper and lower sections of the casing shall be arranged so that they may be held together rigidly with the use of appropriate bolts. The pump suction and discharge nozzles shall be located in the lower section of the casings. The design shall be such that the rotors of the pumps may be exposed for inspection or for removal by resorting to the expediency of removing the top section of the casing, but without disconnecting any part of the main interconnecting pipe systems.

C. Both suction and discharge nozzles shall be provided with appropriate flanges by means of which the proper piping systems may be attached to the pumps. These flanges shall be dimensioned, faced, drilled and spot faced to conform to the latest American Flange Standard.

D. The impellers of these pumps shall be arranged for single stage, double suction service. These enclosed impellers shall be made of bronze. They shall be machined carefully and balanced. Their arrangement shall be such as to minimize end thrust.

E. The pump shafts shall be stainless steel members of liberal proportions. These shafts shall be machined with care, ground to gauge and heat treated.

F. The pump rotors shall be supported in the case of each pump upon two ball type bearings. One ball bearing shall be located on each side of the pump impeller and each shall be in split bearing housings. The design of the split bearing housings shall be such as to make them dust-tight, grease-tight, water-tight with integral bearing arms cast to the main pump frame.

G. The shaft sleeves provided for each pump shall be bronze and shall extend from the hub to the impellers out beyond the stuffing boxes. The sleeves shall be held rigidly to the rotating elements and they shall protect the steel shafts from the corrosive action of the water.

H. Leakage from the discharge side of the pumps to the suction sides shall be prevented by the provision of the cast bronze case wearing rings. The design of these members shall be such that they may be removed and replaced with facility. All water pumps shall also have impeller wearing rings.

I. Pump shaft seal: Seals shall be mechanical. Mechanical seals shall be John Crane Type "1" or approved equal with stainless steel spring and metal parts, ethylene propylene elastomer bellows and solid tungsten carbide sealing face. The seal shall have a minimum life of 8000 hours when the pump is operating at 150 psig suction and 300 degrees F.

J. Each pump shall be coupled to the motor with a Rexnord Thomas flexible disk coupling with a spacer and extended hubs, Type DBZ-C, of the proper size and with coupling guard, or approved equal.

K. Each pump shall be mounted upon a steel bed plate. The proportions of these bed plates shall be such as to accommodate not only the pump in each case but the pump driving member as well. These bed plates shall be provided with continuous drip canal around three (3) sides. Each bed plate shall, moreover, be provided with grout holes and leveling pads, with bolts. Each bed plate shall be arranged with a threaded drainage opening. Bed plates on chilled water pumps shall be

extended sufficiently wide to assure that any dripping from pumps, pump nozzles and companion flanges will fall on the base 3" (three inches) beyond pipe companion flange). See Drawings for construction details of pump base.

L. Provide and deliver to the Owner three complete sets of assembly drawings and repair parts lists for each device, i.e., for the pumps and the motors. The Drawings and literature provided shall relate to the actual units involved. They shall not be of such a general nature as to include details which are not incorporated in the devices. They shall, on the other hand, be so complete that no part or parts are omitted. Three manuals of instructions for the proper care, operation and maintenance of these devices shall be provided, likewise.

M. After the pumps have been built and assembled, they shall be factory tested using shop turbine per Hydraulic Institute Standards and a complete set of test curves shall be obtained. These curves shall be certified by affidavit and delivered in triplicate to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than a minimum of three feet, not including piping and piping appurtenances.

C. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 15 percent of midpoint of published maximum efficiency curve.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Refer to Section 23 05 48 for vibration isolation.

E. Provide line sized shut-off valve (ball or butterfly) and strainer on pump suction, and line sized soft seat check valve and balancing (ball or butterfly with memory stop) valve on pump discharge.

F. Provide air cock and drain connection on horizontal pump casings.

G. Provide drains for bases and seals, piped to and discharging into floor drains.

H. Lubricate pumps before start-up.

I. Alignment: A qualified millwright shall check, align and certify pumps. A reverse alignment procedure utilizing laser instruments shall be used. Alignment shall be performed in both hot and cold operating extremes. The maximum parallel and angular misalignment shall not exceed .002 inch. Record and deliver copies of the alignment report to the Owner’s RCM and include copy of the report in the O&M Manual.

J. Vibration Testing: Vibration velocity readings shall be taken at all bearing locations of all pumps. Pumps driven by variable speed drives shall be tested throughout their range of speeds. Vibration shall not exceed 0.15 inch/second (peak). Record and deliver copies of the test report to Owner’s RCM and include report in the O&M Manual.

END OF SECTION 23 20 00

SECTION 23 20 10– PIPING, VALVES AND FITTINGS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Pipe and Pipe Fittings

B. Valves

1.3 RELATED SECTIONS

A. Division 08 – Access Doors and Frames

B. Division 09 – Painting

C. Section 23 05 16 – Expansion Compensation

D. Section 23 05 48 – Vibration Isolation

E. Section 23 07 19 – Piping Insulation

F. Section 23 21 00 – Hydronic Piping

G. Section 23 06 20.13– Hydronic Specialties

1.4 REFERENCES

A. ASME – Boiler and Pressure Vessel Code (BPVC)

B. ASME BPVC Sec. IX – Welding and Brazing Qualifications

C. ASME B16.1 – Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

D. ASME B16.3 – Malleable Iron Threaded Fittings: Classes 150 and 300

E. ASME B16.4 – Grey Iron Threaded Fittings: Classes 125 and 250

F. ASME B16.5 – Pipe Flanges and Flanged Fittings NPS ½ through 23 Metric/Inch Standard

G. ASME B16.9 – Factory-Made Wrought Buttwelding Fittings

H. ASME B16.18 – Copper Alloy Solder Joint Pressure Fittings

I. ASME B16.22 – Wrought Copper and Bronze Solder-Joint Pressure Fittings

J. ASME B16.26 – Copper Alloy Fittings for Flared Copper Tubes

K. ASME B16.34 – Valves Flanged, Threaded, and Welding End

L. ASME B31.1 – Power Piping

M. ASME B31.3 – Process Piping

N. ASME B31.9 – Building Service Piping

O. ASTM A47 - Ferric Malleable Iron Castings

P. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

Q. ASTM A105 – Standard Specification for Carbon Steel Forgings for Piping Applications

R. ASTM A106 – Specification Standard for Seamless Carbon Steel Pipe for High-Temperature Service

S. ASTM A126 – Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings

T. ASTM A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe

U. ASTM A181 – Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

V. ASTM A182 – Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

W. ASTM A234 - Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

X. ASTM B16 – Standard Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines

Y. ASTM B32 – Standard Specification for Solder Metal

Z. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes

AA. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes

BB. for Steam or Valve Bronze Castings

CC. ASTM B75 - Standard Specification for Seamless Copper Tube

DD. ASTM B88 - Standard Specification for Seamless Copper Water Tube

EE. ASTM B99 – Standard Specification for Copper-Silicon Alloy Wire for General Applications

FF. ASTM B148 – Standard Specification for Aluminum-Bronze Sand Castings

GG. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube

HH. ASTM B302 – Standard Specification for Threadless Copper Pipe (TP), Standard Sizes

II. AAA.AWS A5.8 - Brazing Filler Metal.

JJ. MSS SP-25 – Standard Marking System for Valves, Fittings, Flanges, and Unions

KK. NCPWB - Procedure Specifications for Pipe Welding

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00.

B. Record actual locations of valves, etc. and prepare valve charts.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welder's Certification: In accordance with ASME BPVC Sec. IX**.** Submit welder's certifications prior to any shop or field fabrication. Welder's certifications shall be current within six months of submission.

D. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' documented experience.

B. Installer: Company specializing in performing the work of this section with minimum of three years' documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.12 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 STEEL PIPING:

A. Section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, and steam condensate.

B. Pipe: Unless otherwise indicated, chiller and boiler plant piping shall be Schedule 40, and underground and building piping shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM Designation A53, A106, and A135, latest revisions. Steam condensate shall be Schedule 80.

C. Fittings:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weldbend, Tube Turns, or Hackney Ladish Inc. Attach only to pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed, or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting is to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company, or Walworth Company manufacture (Class 300 for unions).

D. Fabrication:

1. Piping shall be fabricated according to the latest ASME/ANSI B31 Code for Pressure Piping. Welded piping and fittings in chiller and boiler plants shall be fabricated in accordance with ASME/ANSI Standard B31.1 – Power Piping. Direct buried piping mains shall be fabricated in accordance with ASME/ANSI Standard B31.3 – Process Piping. Standard B31.9 – Building Services Piping may be used within buildings. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal in welds. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size, and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes, including one stringer/root, one filler, and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler, and one lacer. In all cases, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

E. Weld Testing:

1. All welds are subject to inspection, visual, X-ray and/or Ultrasound, for compliance with specifications. The owner will, at the owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and re-testing of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1, B31.3, and B31.9, due to the discovery of poor, unacceptable, or rejected welds.

2. Welds lacking penetration, containing excessive porosity or cracks, or found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the ASME/ANSI B31 Code for Pressure Piping, current edition.

2.2 VALVES:

A. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings.

B. All bronze and iron body gate and globe valves shall be the product of one manufacturer for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacture, etc.

C. All bronze valves used in circulating systems and steam systems (low and medium pressure) shall be Class 150 SWP. Bronze valves used in high pressure steam systems shall be Class 300 SWP. Iron valves used for low and medium pressure steam systems shall be Class 125. Iron valves used for high pressure steam systems shall be Class 250. [Austin Campus Only: Gate valves 2" or smaller used in low pressure steam systems shall be Class 300 SWP. Gate valves 2 1/2" or larger used in low pressure steam systems shall be Class 150.]

D. All gate and globe valves shall be union bonnet design.

E. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. Alloys used in all bronze ball, gate, globe, check, or angle valves shall contain no more than 15% zinc. No yellow brass valves will be allowed.

F. Class 300 valves shall be constructed of all ASTM B61 composition.

G. All iron body valves shall have the pressure containing parts constructed of ASTM A126 class B iron. Stem material shall meet ASTM B16 Alloy 360, ASTM 371 Alloy 876 silicon bronze, ASTM B584, or their equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing. [Austin Campus only: All iron body gate valves shall have the body constructed of ASTM A395 ductile iron.]

H. All cast steel body valves shall have the pressure containing parts constructed of ASTM A216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16.34. Stems shall meet ASTM designation A182-F6 chromium stainless steel. Wedges on gate valves may be solid or flexible type and shall meet ASTM A182-F6 chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be A216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13% chromium A182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or ductile iron ASTM A536.

I. All forged steel body valves shall have the pressure containing parts constructed of ASTM A105, grade 2 forged carbon steel. Seat and wedges shall meet ASTM A182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16.34 pressure-temperature rating.

J. All valves shall be repackable under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A126 Class B, gray iron hand wheels.

K. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion, then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.

L. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass valve assembly.

M. Balancing and/or shutoff valves for hot water systems 2” inches and smaller shall be three piece, full port, bronze body ball valves with stainless steel ball and stem. They shall have PTFE seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use on insulated lines.

N. Shutoff valves for chilled water 2” and smaller shall be two piece, full port, bronze body ball valves with stainless steel ball and stem. They shall have PTFE seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use on insulated lines.

O. All balancing and/or shutoff valves 2 1/2" and larger shall be tapped full lug butterfly valves with aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling.

P. All balancing and/or shutoff valves must be capable of providing a bubble tight seal at 200 psi for valves up to 12", and 150 psi for larger valves, when used for end of line service, without requiring the installation of a blind flange on the downstream side.

Q. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 2 1/2" through 6" shall have lever handles which can be set in interim positions between full open and full closed. Butterfly valves 8" and larger, and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators with malleable iron handwheel or crank.

R. Check Valves for Water Systems: Valves 2" and smaller shall have bronze bodies and a regrinding disc and seat with screw-in cap. Valves 2 1/2" and larger shall have iron bodies and be non-slam wafer type with stainless pins and springs, and bronze or stainless steel plates.

2.3 STANDARDS OF QUALITY FOR VALVES:

Size	Service	Media	Class	Milwaukee	Nibco	Crane Co. Stockham or as noted
* 2" & smaller	Ball Valve for Shutoff	Recirculating chilled water	150	BA-400S	T-585-70-66	Apollo 82-140
2" & smaller	Globe & Balancing Valve	Chilled Water, Hot Water	150	590T	T-235-Y	B-22T
2-1/2" & larger	Globe & Balancing Valve	Chilled Water, Hot Water	125	F-2981A	F-718-B	G-512
2-1/2" & larger	Butterfly Valve for Shutoff	Recirculating Chilled and Heating Water	150	ML233E (Lever); ML333 (Gear)	LD-2000	DeZurik BHP Series
2" & smaller	Check Valve	All Water Systems	150	510T	T-433-Y	B-345
2-1/2" & larger	Check Valve	All Water Systems	125	8800*	W-920-W	Crane "Duo-Chek" Series

* Requires extended stem in insulated lines.

1. Note: Valves 8" and larger, and valves used for balancing service regardless of size, shall have heavy-duty weatherproof encased gear operators.

2.4 UNIONS:

A. Provide and install two-piece unions at proper points to permit removal of pipe, valves and various equipment and/or machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at all valves, equipment items, machinery items and other special pieces of apparatus. Unions 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to EPCO.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a two-piece dielectric union shall be used at the transition.

2.5 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A181 Grade I or II or ASTM A105-71 as made by Tube Turns or Hackney Ladish Inc. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9, and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and be rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and be rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. Flange Gaskets

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets for steam piping - All steam flange joints shall use Flexitallic Class 150 spiral wound for low pressure applications and Flexitallic Class 300 spiral wound gaskets for medium or high pressure applications. Raised and flat face flange gaskets shall be Flexitallic compression gauge (CG) style. External ring shall be Type 304 stainless steel and color coded yellow. Filler material shall be Flexite Super and color coded with pink stripe. Equivalents may be submitted with all design data so that an evaluation of the gasket can be made.

3. Gaskets for all other applications: Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16” thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

4. Spares - Contractor shall provide ten spares for every flange size and rating.

D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

Nominal Bolt Dia. (Inch)	**Torque (Foot-Pounds)**
0.25	6
0.3125	12
0.375	18
0.4375	30
0.5	45
0.5625	68
0.625	90

0.75	150
0.875	240
1.0	368
1.125	533
1.25	750
1.375	1020
1.5	1200

3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

6. Inspection - Owner shall verify hot torqueing of all medium and high pressure steam flange bolts.

PART 3 - EXECUTION

Refer to other Sections for service specific requirements.

3.1 EXAMINATION

A. Verify excavations under provisions of Section 23 00 00.

B. Verify that 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.

3.3 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Establish elevations of buried piping outside the building to ensure a minimum of cover. Refer to Section 23 00 00.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Division 09.

L. Excavate in accordance with Section 23 00 00 for work of this Section.

M. Backfill in accordance with Section 23 00 00 for work of this Section.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

3.4 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

END OF SECTION 23 20 00.A

SECTION 23 21 00 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED

A. Pipe and Pipe Fittings

B. Valves

C. Glycol Water Piping System

D. Chilled Water Piping System

1.3 SCOPE OF WORK

A. Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with, or properly incidental to, the construction of complete HVAC piping and accessories systems as indicated on the Drawings, reasonably implied therefrom, or as specified herein unless specifically excluded.

1.4 RELATED WORK

A. Section 08 31 13 - Access Doors

B. Section 09 91 00 - Painting

C. Section 23 20 10. - Piping, Valves and Fittings

D. Section 21 05 48. - Vibration Isolation

E. Section 23 07 19. - Piping Insulation

F. Section 23 06 20.13. - Hydronic Specialties

1.5 REFERENCES

A. ANSI/ASME - Boiler and Pressure Vessel Code

B. ANSI/ASME Sec 9 - Welding and Brazing Qualifications

C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300

D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV

E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV

F. ANSI/ASME B31.9 - Building Services Piping

G. ANSI/AWS A5.8 - Brazing Filler Metal

H. ANSI/AWS D1.1 - Structural Welding Code

I. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless

J. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

K. ASTM B32 - Solder Metal

L. ASTM B88 - Seamless Copper Water Tube

M. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

N. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

O. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9

1.7 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ANSI/ASME SEC. 9, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/AWS D1.1.

1.8 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

C. Include welder's certification of compliance with ANSI/AWS D1.1.

D. Contractor to provide cleaning and flushing plan consisting of the following:

1. Markup of plans indicating which sections are to be flushed at a time, the location of flushing bypasses and pump connections, and the anticipated velocity at each section of pipe.

2. Performance data on pump to be used for flushing

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 WALL, FLOOR AND CEILING PLATES:

A. See Section 23 05 29.

2.2 SLEEVES, INSERTS, AND FASTENINGS:

A. See Section 23 05 29.

2.3 CHILLED AND HEATING WATER PIPING - ABOVE GROUND:

A. See Section 23 20 10.UT and 23 06 20.13.

1. All piping shall be Standard Weight black steel pipe.

2. All unions: Class 300.

3. Low Zone (0' to 150' elevation)

   a. Fittings on piping 2-1/2" and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.

   b. Fittings on piping 2" and smaller shall be Class 150 black malleable iron screw fittings. (Class 300 for unions.)

   c. Valves and strainers: Class 150.

4. High Zone (150’ + elevation)

   a. All fittings to be Class 300, welded construction.

   b. Valves and strainers: Class 300.

2.4 CONDENSOR WATER:

2.5 EQUIPMENT DRAIN PIPING:

A. All factory fabricated or field erected air conditioning units with drain pans, all centrifugal water pumps and all other items or equipment or apparatus that require drains shall be connected with drain line run with adequate slope to a floor drain or other point of discharge as shown on the Drawings. On A.C. units the drain line shall include a properly sized water-sealed trap.

B. All drain piping shall be one inch (1") size minimum or larger as may be indicated on the Drawings. Such piping shall be Type L hard copper tube. The drain piping shall be assembled with adapter tees at each change in direction. Install screw plugs in unused openings for access to rod and clean.

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.

D. After completion, fill, clean, and treat systems. Refer to Section 22 13 16.UT

3.2 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Provide clearance for installation of insulation, and access to valves and fittings.

E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13

F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to weld area.

H. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

I. Install valves with stems upright or horizontal, not inverted.

3.3 FABRICATION OF PIPE:

A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.

B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.

C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

E. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from lying on the ground shall be removed.

F. Procedure for Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.

3.4 APPLICATION

A. Grooved mechanical couplings and fasteners may be used only in accessible locations and for pump fit-up assemblies, when approved by Owner in writing.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install calibrated balancing valves for throttling, bypass, or manual flow control services.

E. Provide spring loaded check valves on discharge of condenser water pumps.

F. Use lug end butterfly valves to isolate equipment.

G. Provide 3/4 inch ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest drain.

3.5 PIPE PRESSURE TESTS:

A. See Section 23 00 00

3.6 CLEANING AND FLUSHING OF WATER SYSTEMS

A. Water circulating systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.

B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. At pipe end locations a temporary bypass will be installed. Bypass shall be *same* size as the supply and return pipe. Prior to flushing the distribution system, the Contractor shall install the temporary bypass and a temporary line size strainer between the supply and return pipes. Contractor shall verify that the isolation valves are open.

D. After the temporary bypasses are installed, the Contractor shall provide and operate one pump which will cause a velocity of 10 feet per second in the branch and main piping. This pump will be provided with a shot chemical feeder and a strainer assembly. If the pump is electric driven, rather than engine driven, the Contractor shall provide all temporary electrical disconnects, wiring, fuses, and other electrical devices that are required for safe operation. The Contractor shall provide temporary meters for all branch piping and one for main piping if a permanent flow meter is not specified.

E. Circulation will be started using the temporary pump. A non-hazardous cleaning compound (Entec 324 or approved equal) shall be added using the shot feeder until the concentration level of 20 parts per million is reached. Once this 20 parts per million concentration is reached, circulation will be maintained for 48 hours. After this period of time, the cleaning water shall be dumped to the sanitary sewer.

F. The bypass piping shall be removed and all piping reconnected to the equipment. The distribution system will then be refilled with city water and circulated with continual bleed and make-up until the water is certified clean by the water treatment consultant, and accepted by the Owner. At the completion of this step an inhibitor, compatible with the Campus utility line system, shall be introduced. All waste water shall be dumped into the sanitary sewer system.

G. After the system is certified as clean, the Contractor shall close the valves. During the flushing procedure, strainers shall be cleaned as often as necessary to remove debris and, in any event, all strainers shall be cleaned by physically removing the strainer screen from the body of the strainer at the end of flushing. Replace strainer basket and gasket. Contractor shall not flush through control valves, coils, etc. Contractor shall provide temporary bypasses at coils and spool

pieces at control valves. Flush the coils individually wasting water to sanitary sewer. Connect coils and install control valves after flushing.

H. Test samples shall be taken at all bypass locations and all tests shall indicate that the entire system has reached a PH, conductivity, and chemical concentration 1evel as approved by the Owner to match present systems. Contractor shall purchase needed chemicals from Owner's chemical treatment supplier.

I. Contractor shall provide a smaller assembly to clean and flush any miscellaneous piping that cannot be included in the initial system flush. All other criteria shall remain the same.

J. Contractor shall add inhibitor to the cleaning and flushing chemicals if, once the system is approved as clean, there is any delay in connecting the new system to the existing system. This is to prevent any corrosion after the new pipe is clean.

END OF SECTION 23 21 00

SECTION 23 25 00 - HVAC WATER TREATMENT

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 HVAC water-treatment systems:

1. Bypass chemical-feed equipment and controls.
2. Biocide chemical-feed equipment and controls.
3. Chemical treatment test equipment.
4. HVAC water-treatment chemicals.
5. Water filtration units for HVAC makeup water.

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating and chilled water shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.

4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
    c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
    d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
    e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

D. Passivation for Galvanized Steel: For the first 60 days of operation.

1. pH: Maintain a value within 7 to 8.
2. Calcium Carbonate Hardness: Maintain a value within 100 to 300ppm.
3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300ppm.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TDS controllers.
6. Biocide feeder timers.
7. Chemical solution tanks.
8. Injection pumps.
9. Chemical test equipment.
10. Chemical material safety data sheets.
11. Centrifugal separators.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

B. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.

3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

B. 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.

1.9 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot water piping, condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 5 gal.
2. Minimum Working Pressure: 175 psig.

2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 100 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Control: Low-voltage signal capable of transmitting 1000 feet.

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
8. Provide BacNet and Modbus interface.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low pH alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.
8. Provide BacNet and Modbus interface.

D. TDS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. Provide BacNet and Modbus interface.
3. Digital display and touch pad for input.
4. Sensor probe adaptable to sample stream manifold.
5. High, low, and normal conductance indication.
6. High or low conductance alarm light, trip points field adjustable; with silence switch.
7. Hand-off-auto switch for solenoid bleed-off valve.
8. Bleed-off valve activated indication.
9. Internal adjustable hysteresis or deadband.
10. Bleed Valves:

a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.

E. Biocide Feeder Timer:

1. Microprocessor-based controller with digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door.
2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
4. Solid-state alternator to enable use of two different formulations.
5. 24-hour display of time of day.
6. 14-day display of day of week.
7. Battery backup so clock is not disturbed by power outages.
8. Hand-off-auto switches for biocide pumps.
9. Biocide A and Biocide B pump running indication.
10. Provide BacNet and Modbus interface.

F. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal.

G. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 23 05 13 "Motors."

H. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

I. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel as described in "Stainless-Steel Pipes and Fittings" Article below; and selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F .

2.3 STAINLESS-STEEL PIPES AND FITTINGS

A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.

B. Stainless-Steel Fittings: Complying with ASTM A 815, Type 316, Grade WP-S.

C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

2.4 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.
2. Four-station rack for open systems.

2.5 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

B. Water Softener Chemicals:

1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.6 FILTRATION EQUIPMENT

A. Centrifugal Separators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Culligan International.
   b. LAKOS;
   c. PEP Filters, Inc.

2. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action and gravity.
3. Housing: With manufacturer's proprietary system of baffles and chambers.

   a. Construction: Fabricate and label steel separator housing to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Inlet: Designed with tangential entry to produce centrifugal flow of feedwater.

c. Vortex Chamber: Designed for downward vortex flow and gravity separation of particles.
d. Collection Chamber: Designed to hold separated particles.
e. Outlet: Near top of unit.
f. Purge: At bottom of collection chamber.
g. Pipe Connections NPS 2 and Smaller: Threaded according to ASME B1.20.1.
h. Pipe Connections NPS 2-1/2 and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606. Provide stainless-steel flanges if tank is stainless steel.

4. Motorized Purge Valve: Gate or plug pattern valve.

   a. Motorized Valves: Butterfly-type, flanged or grooved-end, ductile-iron body, with EPDM valve seat and stem seal; with ASTM B 148 aluminum bronze disc.

5. Strainer: Stainless-steel basket type mounted on pump suction.
6. Piping: ASTM A 53, Type S, F, or E; Grade B, Schedule 40 black steel, with flanged, grooved, or threaded joints and malleable, steel welding, or ductile-iron fittings.
7. Piping: ASTM B 88, Type L copper water tube, copper-alloy solder-joint fittings, and brazed, flanged, or grooved joints.
8. Circulating Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.

   a. Casing: Radially split, cast iron.
   b. Pressure Rating: 125 minimum.
   c. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   d. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   e. Seal: Mechanical.
   f. Motor: ODP motor supported on the pump-bearing frame. General requirements for motors are specified in Section 23 05 13 "Motors."

9. Controls: Automatic control of circulating pump and separator purge; factory wired for single electrical connection.

   a. Panel: NEMA 250, Type 4X enclosure.
   b. Pump: Automatic and manual switching; manual switch position bypasses safeties and controls.
   c. Separator Purge: Automatic and manual.
   d. TDS Controller Interlock: Open separator purge valve with bleed-off control.

10. Support: Skid mounting.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
2. Install water meter in makeup water supply.
3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

F. Install automatic chemical-feed equipment for condenser water and include the following:

1. Install makeup water softener.
2. Install water meter in makeup water supply.
3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into boiler feedwater tank or feedwater supply connection at boiler.

4. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
5. Install TDS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TDS concentration.

6. Install pH sensor and controller with injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH.

7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232100 "Hydronic Piping."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 232010 "Piping,Valves and Fittings."

E. Refer to Section 221317 “Plumbing Specialties" for backflow preventers required in makeup water connections to potable-water systems.

F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

G. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. 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.

B. 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.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article for each required characteristic. Sample boiler water at four-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. At four week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

G. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Section 01 79 00 "Demonstration and Training."

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 23 25 00

SECTION 23 29 23 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Variable Frequency Drives

1.3 RELATED SECTIONS

A. Section 23 05 13 - Motors

B. Section 23 05 48 - Vibration Isolation

C. Section 23 09 23 – Direct Digital Control Systems

D. Section 23 09 93 – Sequence of Operation

E. Section 23 34 16 - Centrifugal Fans

F. Section 23 34 13- Axial Fans

G. Section 23 73 23 – Air Handling Units

H. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

I. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices

F. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices

G. NEMA MG1 - Motors and Generators

H. NFPA 70 - National Electrical Code

I. IEEE - 112B, 587 and 519

1.5 SUBMITTALS

A. Submit complete product data, shop drawings, and wiring diagrams, including the rated input current of the VFD. Data shall clearly indicate the current distortion produced by the VFD (submittal will not be approved prior to receiving this information). See paragraph 2.2E for requirements. Make submittals under the provisions of Section 23 00 00 and Division 01.

1. Where IEEE 519 analysis indicates that a 6 pulse VFD will satisfy the requirements specified within this section, Contractor shall submit request to use 6 pulse VFD. Contractor is to include credit for using a 6 pulse rather than 12 pulse VFD in submittal.

B. Product Data:

1. Provide literature that indicates dimensions, weights, capacities, performance, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring. Coordinate submittal with Direct Digital Controls supplier for interface with building control system.

3. Ratings, including voltage and continuous current and horsepower.

C. Shop Drawings:

1. Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

2. Dimensioned drawings. Outline dimensional drawings of each size and type of variable frequency drive (VFD) proposed for use on this project. Include top and bottom views showing conduit entry and exit space, front and side elevations showing arrangement of devices, ventilation and cooling provisions, required clearances, connection details, and mounting provisions.

D. Prior to Installation, Startup, and Testing:

1. Submit manufacturer's written installation instructions.

2. Submit written procedures for field testing to be performed under Part 3 of this Section. Procedures shall include prerequisite and initial conditions, a list of required test instruments, and forms for documentation of test results. Testing forms shall include the range of acceptance values for each recorded parameter.

E. Following Installation, Startup, and Testing. Submit the following information for record purposes in accordance with the requirements of Division 01, Submittals, prior to Owner acceptance.

1. Records. Final as-built drawings and information for items listed in paragraph 1.5B and 1.5C, this Section.

2. Certified factory production test reports, as specified in Part 3, this Section.

3. Manufacturer’s Field Start-up Report and Certification, as specified in Part 3, this Section.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for routine service, spare parts lists, and wiring diagrams.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.8 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. UL Compliance:

1. Comply with UL 508,

2. Comply with UL 60947-4-1A for Motor Starters and Contactors.

C. IEEE Compliance:

1. Comply with IEEE 112-B, Test Procedure for Polyphase Induction Motors and Generators.

2. Comply with IEEE 519, Harmonic Control in Electrical Power Systems.

3. Comply with ANSI/IEEE C62.41, Surge Voltages in Low-Voltage AC Power Circuits.

D. NEMA Compliance:

1. Comply with NEMA ICS 7.0, AC Adjustable Speed Drives.

2. Comply with NEMA MG-1 for Motors.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.10 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Yaskawa

C. Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.2 GENERAL

A. The variable frequency drive (VFD) motor controller shall convert 208, 480 Volt, three-phase, 60 Hertz power to adjustable voltage (0 - 480V) and frequency (20 - 65 Hz.) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed reduction.

B. The adjustable frequency controller shall be a space vector sine-coded Pulse-Width Modulated (PWM) or IGBT design. Modulation methods which incorporate "gear-changing" techniques are not acceptable.

C. The controller shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.

D. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other VFD's are operated from the same bus.

E. Individual or simultaneous operation of VFD’s shall not add more than 5 percent total harmonic voltage distortion and no more than 5 percent total harmonic current distortion (per IEEE 519) to the normal bus.

1. VFD manufacturer shall perform harmonic analysis based on the electrical one-line diagram.The VFD manufacturer shall provide calculations specific to this installation, showing total harmonic voltage distortion is less than 5 percent.

2. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE Standard 519. The resultant power factor with the addition of the filter shall be a minimum of 97%. All VFD’s shall include a minimum of 5 percent impedance reactors, no exceptions.

3. The VFD shall be provided with a harmonic filter that limits the current distortion to 5% or less. Assume a 98% power factor and nominal voltage and frequency for input conditions.

4. Contractor shall include base bid pricing for 12 pulse VFD as well as deduct pricing for 6 pulse VFD in bid.

F. The VFD shall be provided with a DDC System Interface/Siemens Apogee FLN Protocol Interface.

G. The VFD shall include RFI/EMI filters to prevent high frequency noise interference from migrating back onto the power system and RFI interference with other equipment.

2.3 SCHEDULE

A. In general, capacities of equipment and electrical characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the Owner.

B. Where rating of driven equipment furnished for this project is larger than scheduled or indicated on Drawings, provide variable speed drive suitable for driven equipment. Coordinate submittal data and unit selections with submittal data for driven equipment.

C. Provide VFDs as follows unless otherwise specified on the equipment schedule:

1. For equipment that is redundant provide VFD without a constant speed bypass.

2. For equipment that is not redundant provide VFD with a constant speed bypass.

2.4 BASIC DESCRIPTION

A. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz. despite incoming voltage variations.

B. The controller shall have a continuous output current rating of 100 percent of motor nameplate current.

C. The VFD shall be of the Pulse-Width Modulated type and shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage. The inverter output shall be generated by Darlington power transistors which shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. The drive shall produce an output volts/Hertz pattern to produce adequate starting torque under all conditions and operate smoothly at all operating speeds on variable torque load.

2.5 FEATURES

A. The door of each power unit shall include a "POWER ON” light, a VFD fault light, a VFD run light, stop pushbutton, start pushbutton, a fault reset pushbutton, a "HAND-OFF-AUTOMATIC" selector switch, and a manual speed control potentiometer.

B. The VFD shall be software programmable to provide automatic restart after any individual trip condition resulting from overcurrent, overvoltage, undervoltage, or overtemperature. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.

C. A speed droop feature shall be included which reduces the speed of the drive on transient overloads. The drive is to return to set speed after transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive is to automatically compensate to prevent drive trip.

D. Automatic restart after drive trip or utility failure, software selectable.

E. Speed profile. Individual adjustable settings for start, stop, entry, slope, and minimum and maximum speed points.

F. Process signal inverter. Software selectable to allow speed of drive to vary inversely with input signal.

G. A critical speed avoidance circuit will be included for selection of at least three critical speeds with a rejection band centered on that speed. The drive will ignore any speed signals requiring drive operation within the rejection band.

H. Proportional and integral setpoint process controller with menu driven selection and programming via door-mounted keypad.

I. Pick up a spinning load. The VFD shall be able to determine the motor speed and resume control of a motor which is spinning in either direction without tripping.

J. A door-mounted membrane keypad with integral 2-line, 24-character LCD display shall be furnished, capable of controlling the VFD and setting drive parameters, and shall include the following features:

1. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.

2. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A plain English user menu shall be provided in software as a guide to parameter setting, (rather than codes). Drive parameters shall be factory set in EEPROM and resettable in the field through the keypad. Means of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

K. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power.

L. Constant speed bypass shall be provided to allow the motor to run across the line in the event of VFD shutdown. The transfer from the VFD to the line shall be accomplished manually by means of a selector switch. The bypass circuitry shall be enclosed separate from the VFD in a NEMA-1 cabinet.

M. The bypass cabinet shall include a door-interlocked input circuit breaker, a VFD output contactor, a full-voltage starting contactor (both contactors electrically interlocked), a thermal overload relay to provide motor protection, a phase loss/undervoltage relay and a control power transformer. Mounted on the cabinet door shall be a two line LCD display to indicate status of the bypass operation (i.e. VFD output contactor failure or bypass contactor failure, etc), VFD bypass selector switch, motor fault light, power "ON" light, motor "ON" VFD light, and motor "ON LINE" light. The VFD shall be provided with a BacNet Protocol interface. The bypass shall have four digital inputs for individual safety interlocks and provide voltage and current reading on all 3 phases as well as KW.

N. The drive shall be provided with two isolated form C alarm contacts to indicate VFD failure and run status to the DDC.

O. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

P. Digital display indication of:

1. Speed demand in percent.

2. Output current in amperes.

3. Frequency in Hertz or RPM.

4. Control Mode: Manual/Automatic.

5. Total three-phase KW or output voltage.

Q. At the factory with compatible motor, provide at least three lock-out ranges (50 rpm maximum each), two of which can be used to correct any run test problems.

2.6 SERVICE CONDITIONS

A. The controller shall be designed and constructed to operate within the following service conditions:

1. Elevation. To 3300 Feet.

2. Ambient Temperature Range. 0°C to 40°C.

3. Atmosphere. Non-Condensing relative humidity to 95 percent.

4. AC Line Voltage Variation. -30 percent to +10 percent.

5. AC Line Frequency Variation. 3 Hertz.

6. Output Frequency. Shall be able to operate at the rated motor horsepower up to 90 hertz without damage to the VFD.

2.7 ENCLOSURE

A. VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-12 enclosure. Enclosure shall be UL listed as a plenum rated VFD.

B. Finish. Apply a finish to enclosure cabinet, trim, and doors. Exterior and interior metal surfaces shall be cleaned and finished with electrostatically applied "powder coat" thermoset enamel baked over a rust-inhibiting phosphatized coating.

2.8 PROTECTIVE FEATURES AND CIRCUITS

A. The controller shall include the following protective features:

1. Single phase fault or 3-phase short circuit on VFD output terminals without damage to any power component.

2. Static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection.

3. Static over speed (over frequency) protection.

4. Line loss and undervoltage protection.

5. Power unit overtemperature protection.

6. Electronic motor overload protection.

7. Responsive action to motor winding temperature detectors or thermostatic switches.

8. Isolated operator controls.

9. Input line circuit breakers.

10. Be insensitive to incoming power phase sequence.

11. Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.

12. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.

13. Input line noise suppression with line reactor.

14. Individual transistor overcurrent protection.

2.9 PARAMETER SETTINGS

A. The following system configuring settings shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only.

B. Motor Nameplate Data:

1. Motor frequency.

2. Number of poles.

3. Full load speed.

4. Motor voltage.

5. Motor full load amps (FLA).

6. Motor KW.

7. Current minimum.

8. Current maximum.

C. VFD Limits:

1. Independent accel/decel rates.

2. No load boost.

3. Vmin, Vmax, V/Hz.

4. Full load boost.

5. Overload trip curve select (Inverse or Constant).

6. Min/Max speed (frequency).

7. Auto reset for load or voltage trip select.

8. Slip compensation.

9. Catch-A Spinning-Load select.

10. Overload trip time set.

D. VFD Parameters:

1. Voltage loop gain.

2. Voltage loop stability.

3. Current loop stability.

E. Controller Adjustments:

1. PID control enable/disable.
2. Setpoint select.
3. Proportional band select.
4. Reset time select.
5. Rate time select.
6. Input signal scaling.
7. Input signal select (4-20mA).
8. Auto start functions: On/Off, Delay On/Off, Level Select On/Off.
9. Speed Profile: Entry, Exit, Point Select.
10. Min, Max Speed Select.
11. Inverse profile select (allows VFD speed to vary directly or inversely with input signal.)

2.10 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions. Microprocessor systems must be products of the same manufacturer as the VFD (to assure single source responsibility, availability of service and access to spare parts).

B. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 3 most recent events:

1. VFD mode (Auto/Manual).
2. Date and Time stamped for each fault
3. Elapsed time (since previous fault).
4. Type of fault.
5. Reset mode (Auto/Manual).

C. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2.7 M/Sec. intervals for the 10 intervals immediately preceding a fault trip:

1. VFD mode (manual/auto/inhibited/tripped/etc.).
2. Speed demand.
3. VFD output frequency.
4. Drive inhibit (On/Off).
5. Feedback (motor) Amps.
6. VFD output voltage.

7. Type of fault:

    a. Inverter O/Temp.

    b. Over Voltage.

    c. Detection Error.

    d. Earth Leakage.

    e. Watchdog.

    f. PSU Power Fail.

    g. Manual Test.

    h. Out of Sat 1-6.

    i. Software Fault.

    j. Waveform Gen.

    k. Remote Watchdog.

    l. Thermistor.

    m. Sustained O/L.

    n. Bypass SCR Trip.

D. The fault log record shall be accessible via a RS485 serial link as well as line by line on the keypad display.

2.11 SYSTEM OPERATION

A. With the H-O-A switch in the "HAND" position, the drive shall be controlled by the manual speed potentiometer on the drive door.

B. With the H-O-A switch in "AUTOMATIC", the drive shall start remotely through the EMS and its speed shall be controlled by a 4-20mA, internally isolated signal from the local Powers Control Panel.

C. With the H-O-A switch in the "OFF" position, the run circuit will be open and the VFD will not operate.

2.12 QUALITY ASSURANCE AND FACTORY TESTS

A. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

1. Power transistors, SCR's and diodes shall be tested to ensure correct function and highest reliability.

2. Controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

B. Manufacture of VFD shall certify in shop drawings that VFD and equipment motors are compatible. Contractor shall provide VFD manufacturer complete motor data prior to submittal of shop drawings.

C. Manufacturer shall provide a 3 year warranty on parts and labor to owner for each VFD from date of acceptance by Owner.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under the provisions of Section 23 00 00.

B. Deliver products on site in factory fabricated protective containers, with factory installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place, elevated above grade, and protected from weather, sunlight, dirt, moisture, corrosion, and construction traffic.

D. Handle carefully to avoid damage to components, enclosures, and finish. Use only lifting eyes and brackets provided for that purpose. Damaged products shall be rejected and shall not be installed on the project.

E. The manufacturer's representative shall provide a list of recommended spare parts.

F. The manufacturer's representative shall provide terminal block to terminal block wiring diagrams coordinated with the owner to provide a complete and functional operating system. Furnish detailed drawings showing construction, dimensions, wiring diagrams and installation procedures for engineer's approval.

G. As part of the purchase price and agreement, a full, unconditional, one (1) year warranty on all parts and labor shall be provided. The warranty shall include all parts, labor, shipping, field service or technician time, labor or travel expenses and verbal or written correspondence with the VFD manufacturer or his representatives, including that which might be incidental to the proper installation and operation of the equipment.

3.2 PREPARATION

A. Verify that surfaces are ready to receive Work.

B. Verify that field measurements are as shown on Shop Drawings and as instructed by manufacturer.

C. Verify that required utilities are available, in the proper location, and ready for use.

3.3 INSTALLATION

A. Install VFD in accordance with manufacturer’s published, printed instructions.

B. Mounting: VFD's shall be wall hung units. Contractor shall provide Unistrut mounting bracket for drives. Contractor shall reinforce the wall studs with bracing as required to adequately support the drive. Installation of the VFD shall allow for clearance in front of the drive as required by the latest revision of the National Electric Code for an electrical panel.

1. Mount VFD on Unistrut frame anchored to 4-inch thick concrete pad. Do not mount VFD on wall.

2. Height. In general, mount units so that operating handle is approximately 60 inches above finished floor. Where grouped, align tops of units.

3. Ensure that proper clearance is provided for enclosure as required per NEC Table 110.26(A)(1) for working clearance and dedicated equipment space. Ensure that proper clearance is provided for enclosure as required by manufacturer for proper cooling of VFD.

C. Coordinate with Division 26 to complete raceway, power wiring, and grounding in accordance with the requirements of the NEC and the recommendations of the VFD manufacturer as outlined in the installation manual.

D. Contractor shall verify the existence and proper installation and operation of auxiliary contact on all disconnects located between the load and the drive. Auxiliary contact shall command the VFD to shut down as required to protect the VFD from damage. Any disconnects found lacking this function shall be corrected prior to the startup of the equipment.

E. Interface:

1. Controls. Coordinate with the controls supplier to accomplish proper interface with the building automation system (BAS) direct digital controls (DDC). Refer to Division 23 for Direct Digital Controls.

2. Fire Alarm. Coordinate with Division 28 and the fire alarm supplier to accomplish proper interface with the fire alarm system, as indicated on the Drawings. Refer to Division 28, Fire Alarm System.

3. Shutdown. Coordinate with other divisions to accomplish proper interface for shutdown of VFD, as indicated on the Drawings and as specified in the construction documents.

F. Immediately prior to final acceptance, replace all air filters in VFD.

G. Manufacturer shall provide start-up services and training as follows:

1. Start-up for Contractor to verify correct installation and proper operation.
2. Start-up for Controls Vendor to verify that VFD correctly responds to control command functions and provides alarm condition to control center.
3. Provide minimum two-day training, four (4) hours per day for up to twelve (12) people. The course shall be classroom instruction complete with visual aids, documentation, circuit diagrams and hands-on training. This course shall not be construed as a sales meeting, but rather as a school to familiarize the Owner with the care, troubleshooting, and servicing of the VFD.

END OF SECTION 23 29 23

SECTION 23 31 00 - DUCTWORK

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED

A. Low Pressure Ducts

B. Medium and High Pressure Ductwork

C. Casings

1.3 RELATED WORK

A. Division 09 Section, Painting, priming or coating of metal ductwork exposed to view.

B. Section 23 05 48 - Vibration Isolation

C. Section 23 07 13 - Duct Insulation

D. Section 23 33 00 - Ductwork Accessories

E. Section 23 36 00 - Air Terminal Units

F. Section 23 37 00 - Air Inlets and Outlets

G. Section 23 05 93.A - Testing, Adjusting and Balancing

1.4 REFERENCES

A. ASHRAE - Handbook of Fundamentals; Duct Design

B. ASHRAE - Handbook of HVAC Systems and Equipment; Duct Construction

C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

D. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

E. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

F. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality

G. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate

H. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

I. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems

J. SMACNA – HVAC Duct Construction Standards, 1995

K. UL 181 - Factory-Made Air Ducts and Connectors

L. SMACNA Round Industrial Duct Construction Standards,.

M. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).

N. Assembly and Installation of Spiral Duct and Fittings, IMC.

O. Engineering Report No. 132 (Spacing of Duct Hangers), IMC.

P. AWSD1.1 American Welding Society Structural Welding Code

1.5 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: 3 inch WG positive or negative static pressure and velocities less than 1,500 fpm.

C. Medium Pressure: 6 inch WG positive static pressure and velocities greater than 1,500 fpm.

D. High Pressure: 10 inch WG positive static pressure and velocities greater than 2,500 fpm.

1.6 SUBMITTALS

A. Product Data

1. Provide product data for all ductwork systems to be used on project. Product data submittals shall include the following as a minimum:

   a. System name and type

   b. Duct system design pressure

   c. Hangers and supports, including materials, fabrication, methods for duct and building attachment.

   d. Sealant type.

B. Shop Drawings shall be submitted on all items of sheet metal work specified herein. Shop Drawings of ductwork at air units shall be submitted at a minimum scale of 3/8" equal to one foot. Shop drawings of ductwork located at all other locations shall be prepared at a scale of not less than ¼” = 1’-0”. Reproduction and submittal of the construction documents is not acceptable. Shop drawings shall include the following:

1. Clearance dimensions between ducts and dimensions above finished floors for bottom and tops of ducts.

2. Call out of duct materials other than galvanized including but not limited to stainless steel, aluminum, or prefabricated fire rated ductwork.

3. Shop Drawings shall indicate location of all supply, return, exhaust and light fixtures from the approved reflected ceiling plans.

4. Shop drawings shall identify all duct sizes, reinforcement and spacing.

5. Penetrations through fire rated and other partitions.

6. Show major equipment with ductwork connections.

C. Show all dampers, turning vanes, access doors, fire dampers and all other ductwork accessories to be provided. Submit shop drawings and product data under provisions of Section 23 00 00.

D. Submit two samples of stainless steel welded duct joint to Engineer and Owner for approval. After approval, sample shall remain at job site for reference. [NOTE TO ENGINEER: Discuss with owner to understand if other types of ductwork samples are required for project].

E. Welding Certificates. Provide for all welders including procedures and standards of acceptance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 DUCTWORK GENERAL:

A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA Duct Manuals where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein. All exhaust ductwork including toilet room exhausts shall be constructed and leak tested as specified for medium pressure supply ducts at negative pressure.

B. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner. The work shall be guaranteed for a period of one (1) year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Architect.

C. All duct sizes shown on the Drawings are air stream sizes. Allowance shall be made for internal lining where required, to provide the required cross sectional area.

D. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

E. Except for special ducts specified elsewhere herein, all sheet metal used on the project shall be constructed from prime galvanized steel sheets and/or coils up to 60" in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on ten foot (10') centers with manufacturer's name and must be visible after duct is installed. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

F. Where ducts that are exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

2.2 DUCTWORK LOW PRESSURE: (INCLUDES ALL EXHAUST DUCTWORK DOWNSTREAM OF FANS.)

A. The scope of low pressure ductwork is defined as all ductwork downstream of terminal units, and all exhaust ductwork downstream of fans. Construction of all low pressure duct shall be in accordance with Low Velocity Duct Construction Standards as published by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and shall be sealed and tested at 3" static with the same test procedures as medium pressure ductwork.

B. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

C. The metal gauges listed in the 1995 SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct are the minimum which shall be used for this project. It shall be noted that the Contractor is responsible that the metal gauge selected is heavy enough to withstand the physical abuse of the installation.

D. Elbows shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing. 90˚ mitered elbows are not acceptable unless approved by the Architect/Engineer or Project Manager.

E. SEALANT: All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Polymer Adhesive "Airseal #11", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Thane " (United McGill Corp.) polyurethane based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. At contractor's option, Hardcast 1602 sealant tape may be used in lap joints and flat seams.

2.3 DUCTWORK MEDIUM PRESSURE: (INCLUDES ALL EXHAUST DUCTWORK UPSTREAM OF FANS).

A. The scope of medium pressure ductwork is defined as all ductwork downstream of all air handlers, up to and including terminal units, plus all return air ductwork. Construction of all ducts shall be in accordance with High Velocity Construction Standards as published by SMACNA. All round and rectangular duct construction, duct fittings, dampers, etc., are covered in this manual and it is to be adhered to.

1. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

2. The metal gauges are listed herein for round duct and for rectangular duct.

B. All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Thane" (United McGill Corp.) polyurethane based sealant shall be used. No other sealants may be used. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

C. Oval ducts shall be spiral flat oval or welded flat oval equal to those of United McGill Sheet Metal Company with gauges and reinforcing as recommended by the manufacturer for medium pressure or the ducts may be Shop fabricated of completely welded construction of the following gauge:

1. Major Axis 12 to 20 No. 24 gauge
2. Major Axis 20 to 30 No. 22 gauge
3. Major Axis 30 to 46 No. 20 gauge
4. Major Axis 46 to 50 No. 18 gauge
5. Major Axis 50 and Up No. 16 gauge

D. Oval fittings shall be equal to those of United McGill Sheet Metal Company with requirements, sealing, etc., similar to that specified for round medium pressure work.

E. Oval duct reinforcing methods shall be submitted as Shop Drawings for approval. Reinforcing galvanized angles shall be of sizes specified for same size rectangular ducts. Galvanized angles shall be used where standing seams are specified for rectangular ducts. Attaching methods shall be shown on Shop Drawings and submitted for approval.

F. Testing of Medium Pressure Ductwork: (Includes from fan discharge through to the discharge of terminal units.)

1. All medium pressure ducts shall be pressure tested according to SMACNA Chapter 10 test procedures. Design pressure for testing ductwork shall be six inches (6") of water. Total allowable leakage shall not exceed 1% of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all Sections shall not exceed the total allowable leakage.

2. The entire system of medium pressure ductwork shall be tested, including the VAV/Constant Volume Terminal Units (i.e. The ductwork shall be capped immediately prior to the Terminal Units, and tested as described above). After testing has proven that the ductwork is installed and performs as specified, the terminal units shall be connected to the ductwork and the connections sealed with extra care. The contractor shall inform the project inspector when the joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage in the terminal unit connections/joints after the systems have been put into service, the leaks shall be repaired by: 1) complete removal of the sealing materials, 2) thorough cleaning of the joint surfaces, and 3) installation of multiple layers of sealing materials.

3. At the option of the Owner, the Contractor may be allowed to eliminate the terminal units from testing by capping the supply ductwork prior to the terminal units, then inspecting the connection to the terminal units when complete. <u>This option may only be exercised by the Resident Construction Manager, and then only if documented in writing prior to testing</u>.

G. All exhaust ductwork, including toilet room exhausts, shall be constructed as for medium pressure ducts and shall be tested for leaks in the same manner as for medium pressure supply ducts.

H. Contractor may use DUCTMATE or Ward flanged Duct Joint system, reference SMCNA FIG. 1-4 “Transverse Joints” T-25a or T-25b on rectangular ductwork. Slip-on duct flanges are not acceptable. Contractor may at his option (where space permits) use rectangular ductwork with DUCTMATE or Ward system in lieu of oval ductwork.

I. Rectangular 90 degree elbows shall be constructed with single thickness turning vanes mounted on an integral rail. Mitered 90 degree elbows are not allowed unless approved by the Engineer and Construction Manager. Radius type rectangular elbows shall have a centerline radius of 1-1/2 times the duct diameter or width. . Elbows in round or oval ducts may be smooth long radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.

[NOTE TO THE ENGINEER: THE FOLLOWING TWO SUB-SECTIONS (2.04 & 2.05) SHOULD BE USED ONLY WHEN SECTION 23 73 23 - AIR HANDLERS IS NOT USED OR THE PLENUMS ARE OUTSIDE THE SCOPE OF THE FACTORY FABRICATED UNITS.]

2.4 MIXED AND R. A. (LOW PRESSURE) CASING PLENUMS:

A. All low pressure casings and plenums shall be following gauges and construction:

Casing Height	Galv	Alum.	Angles	Standing Seams
Up to 4'	20 ga.	.051	1 x 1 x 1/8"	1"
4' to 6'	18 ga.	.051	1 x 1 x 1/8"	1"
6' to 8'	18 ga.	.064	1-1/2 x 1-1/2 x 3/16"	1-1/2"
8' to 10'	18 ga.	.064	1-1/2 x 1-1/2 x 3/16"	1-1/2"
Over 10'	16 ga.	.064	2 x 2 x 3/16"	1-1/2"

B. All low pressure casings shall be fabricated by the Mechanical Contractor enclosing the filter and automatic dampers as shown on the Drawings. The casing shall be fabricated of galvanized sheet metal erected with 3 foot center maximum standing seams reinforced with 1/4 inch bars. The casing shall be stiffened on three foot centers maximum with angle irons tack welded in place.

C. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed as shown and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside.

D. Casings shall be anchored by the use of angle irons sealed and bolted to the curb and floor of the apparatus casing. Submit Shop Drawings for approval. The casing shall be tested and provided tight at a pressure of three inches water column.

E. The casing shall have 1" thick duct liner applied as specified under paragraph "Duct Liner" in this section.

2.5 MEDIUM PRESSURE BUILT-UP UNIT CASINGS:

A. All medium pressure unit casings shall be fabricated by the Mechanical Contractor and shall enclose the filters and automatic dampers. Casings shall be constructed of cellular, standing seam panels with 3" deep reinforced "hat" sections as manufactured by metal deck manufacturers and as shown and described in SMACNA High Velocity Duct Standards Manual. Shop Drawings shall be submitted for approval showing casing construction details and equipment layout and mounting. Shop fabricated cellular sections are acceptable under the foregoing conditions if evidence is provided to show ability of cellular section to withstand the static pressures of the system.

B. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed for easy access to equipment and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches that can be operated from both the inside and the outside. Hinges shall be equal to Ventlok #370.

C. Casing shall be anchored by the use of galvanized angle irons sealed and bolted to the curb and floor of the apparatus casing as shown on the SMACNA Drawings.

D. A fan discharge diffuser plate shall be located on the fan discharge and shall be constructed of 10 gauge steel perforated plate installed in 6" channel iron frames (8.2#) rigidly supported to withstand the high velocity discharge of the fan. Perforations shall be 3/8" (.375") staggered on 11/16" centers (27% open area). One section shall be hinged to provide an access door between the discharge side of the fan and the entering side of the coils. After fabrication of diffuser plate, coat it with rust resistant paint. After installation, touch-up diffuser plate and paint channel iron frames with rust resistant paint.

E. Casing shall have sufficient access openings to allow access for maintenance of all parts of the apparatus. Access door size shall be as large as feasible for the duty required.

2.6 ELBOWS:

A. Where rectangular elbows are shown, or are required for good air flow, contractor shall provide and install turning vanes. Turning vanes shall be factory fabricated with integral support rail. Radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Submit Shop Drawings on factory fabricated and job fabricated turning vanes. Provide turning vanes in all rectangular radius elbows and offsets.

B. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks.

2.7 FLEXIBLE DUCTS:

A. Low Pressure Insulated Flexible Duct may be used where shown on the drawings. Duct shall be made with factory preinsulated duct supported by a corrosion resistant metal spiral, or a coated spring steel helix and solid inner liner mechanically interlocked or permanently bonded to the helix wire,.covered with a minimum of 1-1/2" thick, 3/4 lb. density fiberglass blanket sheathed in a vapor barrier of fiberglass reinforced aluminum foil and Mylar laminate. The insulation shall have a minimum "K" factor of 0.29 at 60 degrees F. mean and a vapor barrier permeability rating of 0.05 per ASTM method E96-66, Procedure A. The C factor shall be 0.24 to meet HUD requirements. The duct shall be rated for a positive working pressure of 10" w.g. and a temperature of up to 250 degrees F. The duct shall comply with NFPA 90A and be listed and labeled by Underwriters Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread, not over 25; smoke developed, not over 50. Flexible ducts shall be not more than 5'-0" in length, shall be installed as indicated in the diffuser connection detail, and shall be Flexmaster Type 1M or approved equal.

1. The terminal ends of the duct core shall be secured by compression coupling or stainless steel worm gear type clamp equal to Ideal Series 56 Snaplock. The fittings on Air Devices and on sheet metal duct shall be coated with the sealant specified for low pressure ductwork, then flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with more sealant. Insulation of flexible duct shall be slipped over connection to point where insulation abuts mixing box or insulation on duct. These insulation connections shall be sealed by imbedding fiberglass tape in the sealant specified for medium pressure ductwork and coating with more sealant to provide a vapor barrier. (This applies to all flex connections to diffusers, grilles, etc. when allowed on the drawings.)

2. Medium and High Pressure Insulated Flexible Duct shall be factory applied insulation of 1" minimum thickness, 3/4 lb. density with a permeability rating of 0.30. The duct shall be composed of dead soft, spiral wound, triple locked corrugated aluminum core covered with Ratings shall be as described for Low Pressure Duct above. Flexible ducts shall be not more than 2'-0" in length, used for alignment or sound/vibration purposes only, and may only be installed in straight runs. Flexible duct shall NOT be used for changes of direction of air flow,and shall be Flexmaster Type TL-M or approved equal. Installation, clamps and sealing shall be the same as specified for rigid duct.

2.8 DUCT LINER:

A. Where indicated on the Drawings, ducts shall have lining equal to Fiberglass Aeroflex No. 150 duct liner. Duct liner shall be one inch (1") thick unless otherwise indicated. The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with fireproof 3M #37 or St. Clair R41B adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "buttered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over twenty-four (24") in width or depth, the liner shall be further secured with mechanical fasteners. The fasteners shall be A. J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive. The clips shall be eighteen inch (18") maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. Where ducts are lined exterior insulation will not be needed unless otherwise noted, except that the two insulations shall not lap less than twenty-four inches (24"). Dimensions given on the Drawings are metal sizes. Refer to Section 23 00 00 for Flame-Spread Properties.

B. Duct liner in medium pressure ducts shall be the same except a perforated metal liner shall be used over duct liner for securement in lieu of fasteners.

2.9 FACTORY LINED ACOUSTICAL DUCTS: (NOTE: MUST APPEAR ON THE DRAWINGS.)

A. Where indicated on the Drawings, furnish and install double wall internally insulated duct and fittings.

B. Duct shall consist of outer metal pressure shell, 1" thick glass fiber insulation and internal perforated metal liner.

C. Duct and fittings shall be equal to Acousti-K 27 as manufactured by United McGill Sheet Metal Company.

2.10 ALUMINUM DUCTWORK:

A. Provide aluminum ductwork only where indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Obtain manufacturer's inspection and acceptance of fabrication and installation of fiberglass ductwork prior to beginning of installation.

C. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with

spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

E. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

F. Connect terminal units to medium or high pressure ducts directly or with two feet maximum length of flexible duct. Do not use flexible duct to change direction. Allow for a minimum of 3 diameters of straight duct to the entrance of all terminal units.

G. Connect diffusers with 5'-0" maximum length or troffer boots with 2' maximum length of flexible duct to low pressure ducts. Hold in place with strap or clamp, and seal as specified.

H. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 LOW PRESSURE DUCT SUPPORTS:

A. See Section 23 05 29.

3.3 MEDIUM PRESSURE DUCT SUPPORTS:

A. See Section 23 05 29.

3.4 DUCTWORK APPLICATION SCHEDULE

AIR SYSTEM	**MATERIAL**
Untreated Outside Air Intake	Galvanized Steel
Medium Pressure Supply	Galvanized Steel
Low Pressure Supply	Galvanized Steel
Return/Relief Air	Galvanized Steel
General Exhaust Air	Galvanized Steel

3.5 CLEANING OF SYSTEMS:

A. Before turning the installation over to the Owner, all ducts should be cleaned and blown free of all dust and dirt that has collected in the ducts.

END OF SECTION 23 31 00

SECTION 23 33 00 – DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED

A. Manual and Automatic Volume Control Dampers

B. Fire Dampers

C. Combination Fire/Smoke Dampers

D. Backdraft Dampers

E. Air Turning Devices

F. Flexible Duct Connections

G. Duct Access Doors

H. Duct Test Openings

I. Gravity Ventilator Hoods

1.3 RELATED WORK

A. Products installed, but not furnished under this section include airflow stations and automatic control dampers to be provided by Controls Contractor under section 23 29 23.

B. Section 23 05 48 - Vibration Isolation

C. Section 23 31 00 - Ductwork

D. Section 23 36 00 - Air Terminal Units: Medium and High Pressure Damper Assemblies

1.4 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems

B. SMACNA - Low Pressure Duct Construction Standards

C. UL 33 - Heat Responsive Links for Fire Protection Service

D. UL 555 - Fire Dampers and Ceiling Dampers

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 00 00.

B. Provide shop drawings for shop fabricated assemblies indicated, including manual volume dampers, automatic control dampers, duct access doors, and duct test holes. Provide product data for hardware used.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00 for fire dampers and combination fire and smoke dampers.

PART 2 - PRODUCTS

2.1 DAMPERS

A. Furnish and install manual volume dampers where shown on the drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return and exhaust ducts, each individual air supply outlet and fresh air ducts. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, No. 644 on exposed externally insulated ductwork and No. 677 (2 5/8" diameter) chromium plated cover plate for concealed ductwork not above lay in accessible ceilings. Furnish and install end bearings for the damper rods on the end opposite the quadrant when No. 555 or No. 644 regulators are used, and on both ends when No. 677 regulators are used.

C. On concealed ductwork above lay in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.

D. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.

E. Manual volume dampers shall be equal to Ruskin model CD60, Greenheck model VCD-33, or approved equal. Blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16-gauge galvanized steel supported on one-half inch (1/2") diameter rust proofed axles. Axle bearings shall be the self lubricating ferrule type.

F. Install all automatic control dampers, furnished by the Temperature Control Manufacturer, in strict accordance with the manufacturer's recommendations and requirements of these Specifications.

All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.

2.2 FIRE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Fire Dampers

1. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.

2. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1 1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters Laboratories labeling procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.

3. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.

4. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated airflow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch water gauge.

5. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch by 1 1/2 inch by 14-gauge and bolted, tack welded or screwed to the sleeve at maximum spacing of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6" water gauge static pressure.

6. The damper installation shall be in accordance with the damper manufacturer's instructions.

7. All fire dampers shall comply with the specification as written above and shall be Ruskin model DIBD2 (Style C, CR or CO), Greenheck model DFD 150 or DFDR-150 (Type C, CR or CO), or Pottorff model VFD-10D-A.

8. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.

9. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design airflow at the point of installation. The minimum closure pressure rating shall be 8” wg for airflow in either direction.

B. Combination Fire/Smoke Dampers

1. Furnish and install where shown on the drawings, or as required by the specifications, combination fire/smoke dampers meeting the following requirements.

2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to it. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gauge pressure and 8 cfm per square foot at 4 inches water gauge pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.)

3. The damper frame shall be a minimum of 20-gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze Oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14-gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees F. The jamb seals shall be flexible stainless steel compression type or lap seal type.

4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators. The manufacturer shall provide a factory-assembled sleeve. The sleeve shall be a minimum of either 20-gauge for dampers where neither width nor height exceeds 48 inches or 16-gauge where either dimension equals or exceeds 48 inches.

5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.

6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat/releasing device. The Firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.

7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.

8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.

9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 6" W.G. static pressure.

10. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin Model FSD60, Greenheck Model FSD 331, or Pottorff.

11. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape to allow for expansion and contraction of the sleeve and damper assembly.

12. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design airflow at the point of installation. The minimum closure pressure rating shall be 8” wg for airflow in either direction.

C. Submittal and Installation

1. The air quantity and free area through each fire and combination fire and smoke damper has been noted on the drawing adjacent to the duct size or wall opening size where such damper is required.

2. Submittal(s) for fire, smoke, and combination fire/smoke dampers shall include the following:

   a. Assign identification numbers for each damper with corresponding number noted on the drawings.

   b. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper.

   c. Provide manufacturer's data of damper and its accessories or options.

3. One sample 18" x 12" damper shall be furnished for the purpose of illustrating damper operation to the Owner's operating and maintenance personnel.

4. Access doors as specified elsewhere shall be provided to make all parts of the damper accessible. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.

5. Contractor shall install each damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555.

6. After each fire damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to the installation of the ceilings, the Contractor shall, as directed by the Construction Inspector, activate part or all the dampers as required to verify "first time" closure. Activation of the damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fusible link of the fire damper, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate. Failure of the damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

2.3 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans, including roof exhausters, flexible connections shall be made using Ventglas fabric that is fire resistant, waterproof, mildew resistant and practically air tight, and shall weigh approximately thirty ounces (30 oz.) per square yard. There shall be a minimum of one half inch (1/2") slack in the connections, and a minimum of two and one half inches (2 1/2") distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system. This does not apply to Air Handling Units with internal isolation.

2.4 ACCESS DOORS

A. Furnish and install in the ductwork, hinged rectangular or round spin in access doors to provide access to all fire dampers mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch (1") of insulation in the door. Where the size of the duct permits, the doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors). Latches for rectangular doors smaller than 18" x 16" shall be Ventlok No. 100 or 140. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10" x 12", complete with latch and two (2) hinges, or twelve inches (12") in diameter. Round access doors shall be "Inspector Series" spin in type door as manufactured by Flexmaster USA, or approved equal. Doors for personnel access to ductwork shall be nominal twenty four inches (24") in diameter.

B. Where these access doors are above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors.

2.5 SCREENS

A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor that lead to, or are, outdoors. Screens shall be No. 16-gauge, one half inch (1/2") mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.6 TEST OPENINGS

A. Furnish and install in the return air duct and in the discharge duct of each fan unit Ventlok No. 699 instrument test holes. The test holes shall be installed in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc.

2.7 DUCT TAPS (CONICAL FITTINGS)

A. Conical fittings shall be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles), even though a volume damper is specified for the air device. A damper is not required for medium pressure duct taps. Spin in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin in fittings in the ducts shall be determined after dual or single duct terminal units are hung or the location of the light fixtures is known to minimize flexible duct lengths and sharp bends.

B. The conical fitting shall be made of at least 26-gauge galvanized sheet metal. The construction to be a two-piece fitting with a minimum overall length of 6 inches and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.

C. Each fitting shall be provided with a minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.

D. Provide flange and gasket with adhesive peel-back paper for ease of application. The fitting shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on-center with a minimum of four screws per fitting.

E. The conical bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

2.8 GRAVITY VENTILATORS

A. Provide gravity ventilators of type, size, and capacity as scheduled on the drawings.

B. Gravity ventilators shall be low silhouette with removable hood, all aluminum with curb cap, 1/2 inch galvanized steel square mesh birdscreen, and backdraft damper. Provide motorized damper in lieu of backdraft damper as indicated on the drawings.

C. Provide prefabricated 16-gage galvanized steel roof curb with mitered corners. Mount unit on a minimum 12” high curb base with 1-1/2 inch thick 3 pound density rigid fiberglass insulation adhered to inside walls between duct and curb. Provide curb with built-in cant and mounting flange for flat roof decks, and 2 inch treated wood nailer.

D. Gravity ventilators shall be coated in a factory baked enamel finish. The color of the finish shall be coordinated with the Owner/Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions.

B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers only where indicated.

C. Provide balancing dampers on medium or high pressure systems where indicated.

D. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

E. Demonstrate re setting of fire dampers to Owner's representative.

F. Provide backdraft dampers on exhaust fans or exhaust ducts where indicated.

G. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

H. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.

I. Provide duct test holes where indicated and where required for testing and balancing purposes.

END OF SECTION 23 33 00

SECTION 23 29 23 – FANS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Roof Mounted Exhaust Fans

B. Inline Centrifugal Fans

C. Sidewall Propeller Fans

D. Utility/Vent Sets

E. Housed Centrifugal Fans

F. Plenum Fans

G. Drives

H. Fan Accessories

1.3 RELATED WORK

A. Section 23 05 13 - Motors

B. Section 23 05 48 - Vibration Isolation

C. Section 23 07 13 - Ductwork Insulation

D. Section 23 29 23 – Variable Speed Drives

E. Section 23 31 00 - Ductwork

F. Section 23 33 00 - Ductwork Accessories: Backdraft Dampers

G. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

H. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data

F. NEMA MG1 - Motors and Generators

G. NFPA 70 - National Electrical Code

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Shop Drawings: Indicate assembly of fans and accessories including dimensions, installation and mounting details, weights, service clearances, connection locations and types, and electrical connection requirements.

C. Product Data: Submittal data for approval for all fans of every description furnished under this section of these Specifications shall include the following:

1. Manufacturers software selection output that includes:

a. fan curve with specified operating point clearly plotted Brake horsepower, motor horsepower and fan static efficiency

b. System effect allowance (where applicable)

c. Fan and motor RPM

d. Clearly plotted “do not select left of this curve”

2. For fans above 10 horsepower, provide selections for the same fan (motor may vary) at TSP equal to scheduled TSP plus 0.5” wg.

3. Sound power levels for both fan inlet and outlet at rated capacity. Include breakout sound power levels for cabinet mounted fans.

4. Materials of construction

5. Electrical characteristics and connection requirements.

6. All data on fan accessories.

D. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

1.9 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two sets of belts for each belt drive fan, not including the set installed on the fans. Tag sets to identify fan.

PART 2 - PRODUCTS

2.1 GENERAL

A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Conform to AMCA 99.

D. Performance Base: Sea level conditions.

E. Temperature Limit: Maximum 300 degrees F.

F. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

G. Selection Restrictions:

1. Direct drive fans may not be selected to operate at higher RPM than the driving motor nominal RPM rating.

2. Fans furnished with VFDs may not be selected to operate with an input frequency greater than 60 hz.

3. Fans may not be selected to operate in the service factor of the motor.

4. Fans may not be selected to operate in an unstable region of the fan curve (“left of the do not select” curve)

5. Fans may not be selected with a brake horsepower greater than 5% of the scheduled brake horsepower

6. Scheduled fan static pressure is external to the specified product. Fans that include integral backdraft dampers, plenums, energy recovery coils, attenuators, etc must add the pressure drop associated with those accessories to the scheduled static pressure to obtain the total static pressure for fan selection.

2.2 EXHAUST FANS:

A. Belted vent set exhaust fans shall be Cook, Greenheck, Twin Cities, or approved equal. The fans shall be complete with belt guards, heavy-duty gravity shutters, drain holes in scroll, flanged inlet and outlet connections, etc. Motor mounts shall be adjustable for proper alignment and

adjustment of belts. Furnish with a factory applied prime coat of paint. Fans shall be AMCA rated.

B. Centrifugal exhaust fans shall be Cook, Greenheck, Twin Cities, or approved equal, single inlet, single width belted vent fans conforming to the following requirements.

1. Fans, as shown on the Drawings and having the capacities, characteristics and starting equipment shown in the schedule, shall be belt driven (as scheduled) and of the centrifugal type, especially selected for ventilating work. The fans shall run in perfect balance at all speeds, up to a 15% increase above the speeds indicated in the schedule, without noise or excessive vibration in fan or motor. Fan wheels shall be made with backward pitched blades. Blades shall be die-formed, true in shape and held in place by rivets or weld.

2. Fans shall be provided with antifriction bearing of the types specified herein. Shafts shall be made of the best quality steel, turned and ground to close tolerance and shall run true and in perfect balance.

3. Fans shall be arranged for multiple V-belt drives and shall be furnished complete with Vari-Pitch sheaves for single or two belt drives and fixed sheaves for three or more belt drives. Provide a second fixed sheave for final balancing of size as determined after job operating conditions are known.

C. Inline exhaust fans shall be Cook, Greenheck, or Twin Cities, in-line centrifugal or vane axial as approved. Capacity ratings shall be based upon tests performed in accordance with AMCA Standard 210. Each fan shall carry near the unit nameplate the AMCA seal indicating that capacity ratings are certified. Housings for all inline fans shall be of 14-gauge steel minimum and shall have square mounting frame of heavy steel angle to provide for mounting of fan. The fan housing will provide for slip joint duct connection. Fan wheels shall be axial flow type with cast aluminum blades or tubular centrifugal type constructed of welded steel and have airfoil shaped blades. The fan shall be dynamically balanced for smooth operation. The fan shaft shall be solid be solid steel AISI-C1040 keyed to the fan wheel. Grease lubricated bearings shall be selected for a minimum average life in excess of B-10, minimum life 40,000 hours at maximum catalogued operating conditions. Fans shall be provided with factory mounted inlet and outlet sound attenuators when required to meet the scheduled sound power levels. .

D. Propeller or centrifugal roof exhaust air fans shall be Cook, Greenheck, Twin Cities, or approved equal. The fans shall be complete with fans and motors, propeller, motorized dampers factory wired to open when fans are in operation and close when fans are not in operation, bird screens, and round spun aluminum weatherproof protection covers. Fans shall be all aluminum. The fans shall be firmly bolted to the curb on which they rest. Fans shall be AMCA rated. Wing nuts of nonferrous construction shall be provided to remove covers.

E. Propeller wall fans shall be Cook, Greenheck, Twin Cities, or approved equal, belt or direct driven as scheduled on the Drawings. The fans shall be complete with guards over motor side, heavy-duty gravity shutters, etc. Furnish with a factory applied prime coat of paint. Fans shall be AMCA rated.

2.3 RETURN AIR FANS:

A. Centrifugal return air fans shall be Cook, Greenheck, Twin Cities, or approved equal, DWDI and Class II or above as scheduled; belt drive fans (as scheduled) conforming to the following requirements.

1. Fans, as shown on the Drawings and having the capacities, characteristics and starting equipment shown on the schedule, shall be belt driven and of the centrifugal type, especially selected for ventilating work. Fan wheels shall be made with FC, BI or airfoil blades. Blades shall be die-formed, true to shape and held in place by rivets or welds. Fan shaft shall not reduce in diameter at the outboard bearing (opposite of drive end).

2. Fans shall be provided with antifriction bearing of the types specified herein. Shafts shall be made of the best quality steel, turned and ground to close tolerance and shall run true and in perfect balance.

3. Fans shall be provided with quick opening access doors in the fan scroll.

4. Belt driven fans shall be arranged for multiple V-belt drive and shall be furnished complete with Vari-Pitch sheaves for single or two belt drives and fixed sheaves for three or more belt drives. Furnish a second fixed sheave for final balancing of size as determined after job operating conditions are known.

5. Fans and motors shall be mounted on a common pad. See Vibration Isolation Specification, Section 23 05 48.

6. Fan belt guards shall be constructed with heavy steel angle frames and wire mesh panels. Guard shall be removable (four bolt max., or equivalent secure quick dismount) for easy access to belts and pulleys.

2.4 V-BELT DRIVES:

A. All v-belt drives shall be designed for a minimum of 50% overload. Where more than one belt is required, matched sets shall be used. All belt drives shall be furnished with belt guards.

2.5 FAN ACCESSORIES:

A. Inlet bell air flow measurement: Where scheduled or called for in the fan specifications, furnish an inlet cone air flow measurement system per the following requirements

1. Flow monitoring station shall not use air restricting probes that reduce fan performance or create additional fan sound.

2. Flow monitoring station shall accurately measure the pressure differential to within +/- 3% from scheduled air flow to 30% of scheduled air flow.

3. Flow monitoring station to be installed by the fan manufacturer as part of the standard fan assembly.

2.6 MOTORS:

A. Refer to Section 23 05 13 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flexible connections specified in Section 23 33 00 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one-inch flex between ductwork and fan while running.

C. Provide fixed sheaves required for final air balance.

D. Provide safety screen or cage where inlet or outlet is exposed. Plug fans inside walk-in casings shall be provided with hinged safety cage.

E. Pipe scroll drains over to nearest floor or roof drain.

F. Provide motorized dampers on discharge of exhaust fans where indicated. Refer to Section 23 33 00.

G. Unless specified elsewhere, the fan manufacturer shall dynamically balance the fan with the fan set in place, leveled, and ductwork attached, to a vibration velocity less than or equal to 0.200 inches (0.100 inches for direct-drive applications) per second measured on horizontal, vertical, and axial planes at each bearing pad. Vibration amplitudes are in inches/second peak velocity. All values recorded are to be filter-in at the fan speed. Confirm the fan/motor vibration velocity limit over the following operating speed range: Fans with VFDs shall be checked from 15 to 110% of rated fan speed. Constant speed fans shall be checked at 100% of rated fan speed. 'Lock-out' ranges may be used to correct up to two ranges of excess vibration. The span of each 'lock-out' range shall be limited to an effective fan speed of 50 RPM. Any 'lock-out' range used shall be clearly identified in the test report and shall be prominently displayed on a typed, laminated legend mounted inside the VFD controller cabinet. This testing shall be witnessed by a representative of the Owner's Test and Balance Consultant.

H. Failure to confirm vibration velocity limit shall require re-balancing and re-testing until criteria is met. Contractor shall bear all costs involved in the modifications, balancing, and re-testing, including travel and hourly costs associated with the Owner's Test and Balance firm's consultant.

END OF SECTION 23 34 16

SECTION 23 36 00 – AIR TERMINAL UNITS (VAV)

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. 23 00 00 -- Basic Mechanical Requirements

B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors

C. 23 05 53 -- Mechanical Identification

1.2 SECTION INCLUDES

A. Variable Volume Terminal Units

B. Single Duct Terminal Units

C. Integral Sound Attenuator

D. Integral Heating Coils

E. Integral Damper Motor Operators

F. Integral Controls

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 00 - Controls and Instrumentation: Thermostats and Control Components

B. Section 23 05 93.A - Testing, Adjusting and Balancing

C. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

D. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 RELATED SECTIONS

A. Section 23 05 13 - Motors

B. Section 23 31 00 - Ductwork

C. Section 23 33 00 - Ductwork Accessories

D. Section 23 37 00 - Air Outlets and Inlets

E. Section 23 09 00 - Controls and Instrumentation

F. Section 23 05 93.A - Testing, Adjusting and Balancing

G. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

H. Section 26 27 26 - Wiring Devices and Floor Boxes

1.5 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems

B. UL 181 - Factory-Made Air Ducts and Connectors

C. ADC 1062 - Air Distribution and Control Device Test Code

D. ARI 880 - Standard for Air Terminals

1.6 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.

D. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch wg, submit minimum air flow for heating coil operation and minimum airflow for flow measurement within specified accuracy

E. Submit Manufacturer's installation instructions under provisions of Section 23 00 00.

F. A sample 8-inch size production run unit shall be submitted for examination and approval by the Engineer, RCM office and the Owner's Testing and Balancing (TAB) Consultant. This submittal box shall be submitted, in addition to the required written submittal, well in advance of any requirement for installation of boxes, but absolutely no later than 60 days after the date of the start of construction stipulated in the Work Order letter from the Owner to the General Contractor. A minimum of three weeks shall be allowed by the Contractor for the testing of the box from the time of submittal to the time of determination of project worthiness. This period shall restart if the sample box is rejected and another box is resubmitted. If rejected for any reason, the Contractor shall expedite the corrections documented, and shall resubmit a sample box as soon as possible. Any delay in the submittal of the box for approval shall not be grounds for a claim of delay on the part of the Contractor. If approved, the unit shall remain in the possession of the Owner at the job site for comparison with units as shipped to project. The unit shall be installed in the project, at an accessible, marked location. The unit Manufacturer shall test and certify that each box used on this project has been tested as specified.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include Manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' documented experience.

1.9 WARRANTY

A. Provide one-year Manufacturer's warranty under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 VARIABLE OR CONSTANT VOLUME TERMINAL UNITS:

A. The Contractor shall provide pressure independent dual duct or single duct (as scheduled) variable air volume control assemblies with integral attenuator (single duct units) and attenuator/mixers (dual duct units) of the sizes, capacities, and configurations shown on the drawings.

B. CASING CONSTRUCTION:

1. The units shall be constructed of a minimum of 22-gauge galvanized steel and internally lined with a minimum of 1 inch thick, three pound per cubic foot density insulation. The insulation shall be foil faced with the edges and seams sealed or "captured", encapsulating all fibers of the insulation. The insulation shall be neatly installed with no rough edges to interrupt the smooth flow of air through the box. Closed cell polymer insulation may be used instead of the fiberglass described above if UL 25/50 labeled. The casing shall be insulated throughout its interior, up to or at least to within 2" of the heating coil connection. Insulation for the heating coil shall enclose the coil casing and tube bends and shall overlap the box internal lining by at least 3". The external insulation shall be as specified in other sections of this specification for duct insulation with full vapor barrier, and shall be field installed unless coil and plenum section is furnished as an integral part of the box.

2. All interior features of the boxes (such as mixing baffles, damper housings, etc.) shall be secured within the casing to avoid excessive movement or rattling with air movement or externally generated vibration. All external features of the terminal units shall be designed not to extend beyond the ends of the unit. (For example, the actuator mounting brackets, etc. shall not extend beyond the plane of the inlet "bulkhead.") The only exception shall be flow sensors installed in the inlet duct connections. Note that if a separate flow station is installed within a frame within the casing, then it shall be so installed not to allow airflow to bypass the flow measurement station.

3. No portion of the VAV terminal shall block access to the flow ring connections on the unit inlets. Note that this will require some manufacturers to mount their control panels further forward than their standard construction.

4. The terminal units shall be constructed with inlet and discharge ductwork connections. The inlet ductwork connections shall extend a minimum of 4 inches from the unit casing including an allowance for the installation of airflow station(s) or probe(s). The discharge connection shall include 1" extension with slip and drive connections for use by the Contractor to secure the discharge ductwork or appurtenances to the unit and shall be reinforced to provide a rigid assembly.

C. CASING LEAKAGE: Assembled units shall be so constructed and sealed to limit air leakage to the following listed quantities at 6" static pressure. If sealing is required to obtain the leakage performance, seal as for medium pressure ductwork Hardcast 1602 tape may be used to seal lap joints and flat seams only. Leakage curves or tables will be required as part of the submittal data. The following is the maximum allowable casing leakage including all components:

Diameter	Maximum CFM (@ 2000 fpm inlet velocity)	Maximum Allowable CFM Casing Leakage
4"-5"-6"	395	8.0
7"-8"	700	14.0
9"-10"	1090	22.0
11"-12"	1570	30.0
13"-14"	2140	40.0

D. ACCESS PLENUM AND DOOR: Single duct units provided with reheat coils also shall be provided with an access section or plenum between the terminal and the coil for coil inspection. The construction of the plenum shall be equal to the quality of materials and workmanship to that of the terminal unit. The access plenum may also be used as a transition, and shall be constructed with a transition angle not to exceed 15 degrees. The access plenum shall contain a minimum of a 12 inch diameter or 12 inch by 12 inch (or full width of unit if less than 12") access door. Door shall be Ventlok Galvanized Sheet Metal Access Door, Flexmaster Inspector Series, Ward DSP or DSA series, or equal. Door frame may be bolted, screwed or flanged and sealed to the casing. Door shall be gasketed and shall be double wall construction or insulated similar to main casing. Door shall be held in place with latches or other captive retainer devices. An additional access panel shall be provided immediately downstream of the dampers for inspection and service of the dampers. If the damper assembly is easily removed from the rear of the box, the access size can be reduced to 8" round or 8" x 8" for inspection only.

1. Access doors and frames shall be thermally broken

E. DAMPER CONSTRUCTION: The damper blades shall be an equivalent of 18-gauge galvanized steel or equal aluminum and shall be securely riveted or bolted through the damper shafts to assure no slippage of the blades. The damper shafts shall operate in rust-proof self-lubricating bearings. Damper shafts penetrating the unit casings shall be sealed against leakage, and bearings shall be installed for protection against wear in the casing penetration. Damper shafts shall be formed of, or cut from solid stock; no hollow shafts will be allowed. The dampers shall seat against gasketed stops or the dampers shall have gasketed edges. Gaskets shall be mechanically fastened to the blades. If the fastening method is not full contact clamping type, then the addition of adhesive to the gasket shall be required. The dampers shall be so constructed to prevent "oil canning" of the damper blade. The units shall be tested for leakage in both inlets with 6" static pressure imposed on one inlet at a time. The maximum percent leakage from all tests shall be reported. Leakage curves as a function of pressure shall be supplied as part of the submittal data. The damper actuator linkage, if used, shall be constructed of material of sufficient strength to avoid buckling under extreme loads. Also, linkages shall not allow play greater than 5 degrees of damper movement. The controls for the dampers shall cause the dampers to fail in the position of last control (freeze in place), or fail to the open position.

F. DAMPER LEAKAGE: The following is the maximum damper leakage allowable for the various size diameter inlets at 6" wg differential pressure. The damper leakage shall not exceed the values listed in the table below at 6" S.P., following ARI 880 Testing Procedures.

Diameter	Maximum CFM (@ 2000 fpm inlet velocity)	Maximum Allowable CFM Damper Leakage
4"-5"-6"	395	6
7"-8"	700	10.5
9"-10"	1090	16.5
11"-12"	1570	20
13"-14"	2140	30

1. UNIT PRESSURE DROP: For dual duct units with an integral attenuator-mixer, but with no other accessories, the static pressure across the assembly with an equivalent 2000 fpm inlet velocity through one inlet shall not exceed 0.5 inches water gauge, with the total flow through either inlet. Single duct unit pressure drop shall be limited to 0.40 inches water gauge under the same conditions above [unless otherwise specifically noted on terminal box schedule]. Units with hot water reheat coils shall have a water side pressure drop of no more than 10 ft of head at the schedule flow.

G. CERTIFICATION: The Unit Manufacturer shall certify that each unit used on this project will perform as specified. Each unit shall bear a tag or decal listing the following specified information:

1. Test Pressure
2. Leakage CFM (damper)
3. Leakage CFM (casing)
4. Date of Mfg.
5. Room or area served
6. Unit size - 6”, 8”, etc.
7. Calibrated CFM, i.e. 800 CFM

H. MIXING: Terminal units as specified herein shall provide mixing within the units, and not rely upon the discharge ductwork to provide for the completion of the mixing process. The horizontal average temperature of the air as it leaves the terminal unit shall not vary more than 1°F for each 20°F. of temperature difference between the two inlet air supplies. (For example, if the cold supply air is 55°F. and the hot supply air is 95°F., the difference is 40 degrees. The allowable temperature variation of the discharge air is, thus, 2°F.) The temperature of the discharge air shall be measured using a pattern of four vertical, evenly spaced columns, and three horizontal, evenly spaced rows. The rows and columns shall be spaced so that the resulting 12 points shall be at the centers of equal areas. The plane of the points shall be perpendicular to the direction of airflow, within 4 inches of the discharge of the terminal unit, within the discharge ductwork. The three readings in each column shall be averaged to determine compliance with the 1° criteria.

I. FLOW MEASUREMENT:

1. Airflow measurement systems shall measure airflow through the inlet connections with 5% of actual airflow between 2000 fpm and 250 fpm with three straight duct diameters on each air inlet connection.

2. Where flow measurement is indicated to be on the discharge side of the air terminal, the manufacturer is responsible for locating the flow measurement device so that it meets the accuracy requirements above from the minimum to the maximum settings for the box and each deck connection. As a substitute, the manufacturer and contractor may elect to provide an external flow measure device and required duct modifications at no additional cost to the owner.

J. SOUND: (Note that the maximum sound levels listed in this paragraph refer to raw sound levels, with no credits taken for the construction.)

1. DISCHARGE SOUND

a. Maximum discharge Sound Power Levels at 2000 fpm primary air inlet velocity with 1.5 inch wg inlet static pressure shall not exceed that listed in the following table. No credit for lined discharge duct, branching, flow division, end reflection, room absorption or any other effects shall be allowed.

Octave Band	Center Frequency (Hz)	Sound Power Level (dB re 10^{-12} Watts)
2	125	76
3	250	66
4	500	63
5	1000	58
6	2000	60
7	4000	55

2. RADIATED SOUND

a. Maximum discharge Sound Power Levels at 2000 fpm primary air inlet velocity with 1.5 inch wg inlet static pressure shall not exceed that listed in the following table. No credit for ceiling plenum, ceiling tiles, room absorption, or any other effects shall be allowed.

Octave Band	Center Frequency (Hz)	Sound Power Level (dB re 10^{-12} Watts)
2	125	72
3	250	67
4	500	64
5	1000	54
6	2000	47

7	4000	45

b. All sound power levels shall be obtained from testing in accordance with ARI-ADC Standard 880 and shall be certified at ARI-880 certification points.

K. TESTING PRIOR TO INSTALLATION:

1. Refer to Submittal Paragraph, this section, for sample unit testing prior to shipment.

2. SHIPMENT TESTING: A minimum of ten percent (10%) of each size of the terminal units (but no less than one unit of each size used) may be tested for conformance to this specification, at the Owner's discretion. The Contractor shall allow sufficient time during construction and space for the Owner's TAB Consultant to perform all testing as may be required.

3. UNIT NON-PERFORMANCE:

a. If the results of the SHIPMENT TESTING show that any of the units do not perform as specified, then an additional ten percent (10%) of each size (but no less than one unit of a size, unless 100% of the size has been tested) of the units shall be tested. If this testing, in the Owner's opinion, shows that ten percent (10%) or more of the units tested do not perform as specified, then one hundred percent (100%) of all sizes of the units shall be tested for conformance with these specifications. The results of that testing shall be reviewed carefully between the Contractor, Manufacturer, the Owner's construction administrator(s), and the Owner's design engineer(s). A method of repair or replacing the units will be negotiated. The Owner, however, shall maintain the right of final approval of any proposed solution.

b. Should for any reason the testing described above under "SUBMITTAL" and "SHIPMENT TESTING" prove that any of the units do not perform as specified, the Contractor shall be responsible for all subsequent labor, travel, travel expenses, and incidental expenses, penalties, or other costs attendant to any additional testing as described under "UNIT NON-PERFORMANCE", or as required to prove that the units perform as specified. This shall include, but not be limited to, the labor, travel and reasonable incidental expenses of not only the Contractor and Owner's TAB Consultant, but also those incurred by the Owner as may be specifically required for this purpose. The expenses to be reimbursed to the Owner shall be labor at a rate of $300 per day or any portion of a day, plus travel and travel expenses at actual cost, plus reasonable incidental expenses at actual cost.

L. MANUFACTURER: All Terminal Units shall be as manufactured by Metal*Aire (Series TH500-ECO or Series 400DDUT), or Nailor Industries (3000-UT or 3200-UT), or Price Industries. *Note that the model and series numbers listed may differ slightly from catalogue information.* No other Manufacturers or models are acceptable. Even though specific Manufacturers may be named herein, the material supplied by any approved Manufacturer shall meet all of the provisions of this specification without exception.

1. Single duct boxes (where specified) shall be the single duct version of the dual duct versions described in the paragraph above.

M. GENERAL PERFORMANCE: If DDC controls of another Manufacturer (NOT the terminal unit Manufacturer) are provided for this project, the terminal unit Manufacturer shall be responsible only for the construction of the terminal unit and the installation of internal control components installed at the Manufacturer's factory, and shall not be responsible for the installation of controls not installed at

the terminal unit Manufacturer's factory, nor shall the Manufacturer be responsible for the performance of the DDC controls. The performance of DDC controls, especially in connection with terminal units, shall be the responsibility of the DDC controls Manufacturer.

N. CONTROL PERFORMANCE: Assemblies shall be able to be reset to any airflow between zero and the maximum cfm shown on Drawings. To allow for maximum flexibility and future changes, it shall be necessary to make only simple screwdriver or keyboard adjustments to arrange each unit for any maximum airflow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection.

O. CONTROL SEQUENCES: Refer to the controls drawings and specifications for sequences of operations for the VAV terminals.

P. DDC SYSTEMS:

1. Electronic motors and controllers shall be installed by the terminal unit Manufacturer unless specifically prohibited by the by the controls Manufacturer. In such an event, the controls Manufacturer shall be responsible for the installation of the controls. The controls Manufacturer shall be responsible for the operational performance of the entire system. The terminal unit Manufacturer shall remain responsible only for the performance of the mechanical components of the unit.

2. DDC Controls Protocol/Description:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Install in accordance with Manufacturer's instructions.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

E. Connect to ductwork in accordance with Section 23 31 00.

F. Install heating coils in accordance with Section 23 82 16.

G. All terminal units shall be installed with a minimum of three diameters of straight duct directly prior to the entry into each terminal unit connection and of the same size as the box inlet neck connection.

END OF SECTION 23 36 00

SECTION 23 37 00 – AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED

A. Diffusers

B. Diffuser Boots

C. Registers/Grilles

1.3 RELATED SECTIONS

A. Section 09 91 00 - Painting: Painting of Ductwork Visible behind Outlets and Inlets

B. Section 23 31 00 - Ductwork

C. Section 23 33 00 - Ductwork Accessories

1.4 REFERENCES

A. AMCA 500 – Laboratory Methods of Testing Louvers, Dampers and Shutters

B. ANSI/NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems

C. ANSI/AHRI 881 - Performance Rating of Air Terminals

D. ANSI/AHRI 885 - Air Terminals

E. SMACNA - Low Pressure Duct Construction Standard.

1.5 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ANSI/AHRI 881 and ANSI/AHRI 885.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.7 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00.

B. Provide product data for items required for this project.

C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.

D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

E. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 AIR SUPPLIES AND RETURNS:

A. Grilles, registers and ceiling outlets shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made. Selections shall meet the manufacturer's own published data for the above performance criteria. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 FPM nor less than 25 FPM. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level). Grilles, registers and ceiling outlets shall be Titus, Metalaire, Price, or approved equal.

B. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

2.2 ROUND CEILING DIFFUSERS

A. Provide round, adjustable discharge pattern, stamped or spun, multicore type diffuser to discharge air in 360 degree pattern. Horizontal to vertical adjustable discharge pattern must be achieved by means of moving cores up or down. Round diffusers shall be constructed of 18-gauge steel.

B. Project diffuser collar not more than one inch above ceiling face and connect to duct with duct ring. In plaster ceilings, provide plaster ring and ceiling plaque.

C. Fabricate of steel with baked enamel finish.

2.3 SQUARE CEILING DIFFUSERS

A. Provide square ceiling diffusers of architectural square panel type with sizes and mounting types shown on plans and schedules.

B. Provide frame type appropriate for ceiling type. For lay in ceilings, diffuser shall fit in inverted T-bar frame. For plaster ceilings, diffuser shall fit in plaster frame and ceiling frame.

C. The face panel of the diffuser shall be smooth, flat, and free of visible fasteners. The face panel shall project no more than 1/4 “ below the outside border of the diffuser back pan.

D. The diffuser face panel shall have an aerodynamically shaped, rolled edge to ensure a tight, horizontal discharge pattern across ceiling.

E. Fabricate of steel with baked enamel finish.

2.4 PERFORATED FACE CEILING DIFFUSERS

A. Provide diffuser with fully adjustable pattern, and removable perforated face.

B. Provide frame type appropriate for ceiling type. For lay in ceilings, diffuser shall fit in inverted T-bar frame. For plaster ceilings, diffuser shall fit in plaster frame and ceiling frame.

C. Diffuser shall discharge a uniform horizontal blanket of air into the room and protect ceiling against smudging. Pattern controllers shall be mounted on the back of the perforated face and must be field adjustable to allow discharged air to enter the room in either vertical or one, two, three, or four way jets. The perforated face must be removable from the back pan to facilitate pattern controller adjustment and damper access.

D. Fabricate of steel with steel frame and baked enamel finish.

2.5 SUPPLY REGISTERS/GRILLES

A. Provide grilles with streamlined and individually adjustable curved blades to discharge air along face of grille, with one-way or two-way deflection as scheduled.

B. Frames shall have 1 ¼" wide border on all sides. Screw holes on frames shall be countersunk so that screw heads sit flush with frame face.

C. Fabricate of aluminum extrusions with factory acrylic paint finish.

D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.6 EXHAUST AND RETURN REGISTERS/GRILLES

A. Grilles shall have fixed deflection blades and shall be of the sizes and mounting types scheduled.

B. Frames shall have 1 ¼" wide border on all sides. Screw holes on frames shall be countersunk so that screw heads sit flush with frame face.

C. Fabricate of aluminum extrusions with factory acrylic paint finish.

D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

E. In gymnasiums, blades shall be front pivoted, welded in place or securely fastened to be immobile.

2.7 CEILING SLOT DIFFUSERS

A. Provide continuous slot diffusers with direction vanes and slot widths as scheduled. The complete slot diffuser system shall include engineered and factory made plenums, hoods, blankoffs, and associated components. All components shall be made by a single manufacturer.

B. The slot diffusers shall integrate into the ceiling system. Where curved linear slot diffusers are indicated, they shall be stretch formed to the exact curve required.

C. The slot diffusers shall have a single slot unless scheduled otherwise and shall be capable of being used for supply, return, exhaust air, or any combination thereof.

D. Linear diffusers supported by screws in flanges or from air plenums are unacceptable. For lay-in ceilings, provide wire hanger support clips integral with the linear slot diffusers allowing the slot diffusers to be supported from the building structure with ceiling wire. For hard ceilings, provide clips that are integral with the slot diffusers allowing the diffusers to be secured directly to the

ceiling framing without hanger supports. Provide spline clips to secure joints and ceiling tees to the diffusers.

E. The slot diffuser systems shall include an engineered plenum and pattern controllers designed to control the throw from the diffuser.

F. Slot diffusers shall be fabricated of aluminum extrusions with factory baked enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to Section 09 91 00.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 00.

END OF SECTION 23 37 00

SECTION 23 41 00 – FILTERS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Filters

B. Housings and Frames

C. Filter Gauges

1.3 RELATED SECTIONS

A. Section 23 05 13 - Motors

B. Section 23 07 13 - Ductwork Insulation

C. Section 23 31 00 - Ductwork

1.4 REFERENCES

A. AMCA 99 - Standards Handbook

B. AMCA 500 - Laboratory Methods of Testing Louver, Dampers, and Shutters

C. ANSI/UL 586 - Test Performance of High Efficiency Particulate Air Filter Units

D. ANSI/UL-900 - Test Performance of Air Filter Units

E. ASHRAE 52 - Method of Testing Air Cleaning Devices

F. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data:

1. Provide data of media, performance data, assembly, and frames.

C. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include instructions for filter installation and reordering.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to media or frames.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation. During construction, if the air units operate at any time, minimum MERV 13 filters shall be installed and kept clean.

B. Provide three sets of filters for each unit. One set of filters is to be installed when unit is started up and shall be protected from construction debris with additional media either at the first bank of filters, or covering each air intake (outside air and return air). The second set of filters is to be installed when test and balance activities begin. At substantial completion, OFPC RCM shall inspect filters to determine if the third set should be installed or delivered to campus operations personnel. Tag filters to identify associated unit.

1.10 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two extra sets for each unit of filters. Tag filters to identify associated unit.

1.11 SCHEDULES ON DRAWINGS:

A. In general, all capacities and characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner. All equipment shall be shipped to the job with not less than a prime coat of paint or as specified hereinafter. Where installation instructions are not included in these Specifications or on the Drawings, the manufacturer's instructions shall be followed. All equipment affected by altitude shall be rated to operate at the altitude where it is installed. Filtration efficiency ratings shall be as described on unit schedules, control diagrams, or component diagrams.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Type "A": Permanent Washable

1. American Air Filter Permanent Metal Air Filters

2. Camfil Farr Type 44

3. Falls Filtration Technologies P5

B. Type "B": 2" Sectional Renewable

1. American Air Filter RenuFrame

2. Camfil Farr

C. Type "C": Replaceable Dry type, Moderate Efficiency

1. Camfil Farr 30/30 – Class I

D. Type "D": Replaceable Dry Type Medium and/or High Efficiency (MERV 13)

1. American Air Filter

2. Cambridge Filter Corporation

3. Camfil Farr Riga-Flo

E. Type "E": 30" Replaceable Dry Type Medium and/or High Efficiency

1. American Air Filter

2. Cambridge Filter Corporation

3. Camfil Farr

F. Type "F": Ultra High Efficiency (HEPA)

1. Flanders (011-C-04-00-1U) (007-C-04-00-1U)

G. Type "G": Activated Carbon

1. Camfil Farr CamSorb 3CF

H. Side Access Housings

1. American Air Filter

2. Camfil Farr (4P) (3P) Universal Glide Pack

I. Frames

1. American Air Filter

2. Camfil Farr Type 8

J. Filter Gauges

1. Dwyer "Magnehelic"

K. Substitutions: Under provisions of Section 23 00 00. The equipment or material supplied by any of these acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.2 GENERAL DESCRIPTION

A. Configuration: Fabricate with fan(s), coils, etc. plus accessories, including:

1. Filters

2. Filter Housings and Frames

3. Filter Gauges

B. Performance Base: Sea level conditions.

C. Fabrication: Conform to AMCA 99 and ARI 430.

D. Performance: Refer to schedules.

2.3 FILTERS:

A. All air filters shall be listed as (Class 1, Class 2) in accordance with Underwriters Laboratories, Inc., Building Materials Director requirements, except ultra-high efficiency filters, (HEPA or ULPA,) shall be manufactured of materials that are so listed by UL. All filters other than the ultrahigh efficiency type are to be rated in accordance with ASHRAE Test Standard 52-76 and performance characteristics are to be published in the manufacturer's literature. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.

B. Type "A": Permanent, Washable: Viscous coated, high velocity filters. The net velocity through the filters shall not exceed 500 fpm. Filters shall be 2" (two inches) thick and the initial clean resistance to air flow shall not exceed 0.10" (one tenth inch) w.g. Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles. Furnish one complete set of spare filters for each system.

C. Type "B": Sectional, Renewable Media: Air filters shall be 2" (two inches) thick adhesive coated glass fiber media pads enclosed in sectional frames of not less than 16 (sixteen) gauge galvanized steel and equipped with a quick opening mechanism for changing filter media. The airflow capacity of the filters shall be based on a net filter face velocity not exceeding 350' (three hundred and fifty feet) per minute with an initial resistance no greater than 0.10" (one tenth inch) water gauge. When used as prefilters, and mounted in the same holding frames as higher efficiency secondary air filters, the airflow capacity may be based on 500' per minute with an initial resistance not to exceed 0.17" water gauge. Filters shall have an average resistance of not less than 70 to 75% when tested in accordance with ASHRAE Test Standard 52.

D. Type "C": Replaceable, Dry Type, Moderate Efficiency: Filters shall be of the pleated media, disposable type, 2" (two inches) deep in direction of airflow, Class 1 MERV 8. Each filter cell shall utilize a nonwoven, lofted cotton media with a net effective area of not less than (4.6) (7.0) square feet of media per 1.0 square feet of filter face area, a media support grid, and enclosing high wet strength cell sides. The 96% free area welded wire support grid shall be continuously bonded to the leaving air face of the media to properly support the radially tapered, pleated media in the air stream through the life span of the filter. The media itself shall be cemented to the inside perimeter of the cell sides to prevent bypass of unfiltered air. Filter efficiency shall average not less than 25 to 30% when tested in accordance with ASHRAE Test Standard 52-76. Initial clean resistance to air flow shall not exceed 0.30" w.g. at 500 fpm filter face velocity. The 24" x 24" size shall be certified to have a dust holding capacity of not less than (200) (265) grams of ASHRAE Test Dust when operated at 500 fpm to a final resistance of 1.0" w.g.

E. Type "D": Replaceable, Dry Type, Medium and/or High Efficiency (minimum MERV 13): Filters shall be 12" deep of the extended surface, supported pleat type. Each filter shall consist of high density, microfine glass fiber media, media support grid, contour stabilizers, and enclosing galvanized steel frame. Media shall be laminated to a nonwoven synthetic backing to form a

lofted surface for maximum dust holding capacity. The edges of the media shall be continuously bonded to the internal surfaces of the galvanized steel frame to prevent bypass of unfiltered air. Filter efficiency shall average not less than (40 to 45%) (50 to 55%) (80 to 85%) (90 to 95%) when tested in accordance with ASHRAE Test Standard 52-76. Filters shall be 24" x 24" x 12" deep with an initial clean resistance not to exceed (0.25) (0.35) (0.50) (0.65) inches w.g. at 500 fpm face velocity. The filters shall be certified to have a dust holding capacity of not less than (700) (400) (235) (130) grams of ASHRAE Test Dust when operated at 500 fpm face velocity to a final resistance of 1" w.g.

F. Type "E": Replaceable Dry Type, Medium and/or High Efficiency: Filters shall be of the extended surface, unsupported, pocket type, approximately 30" deep in direction of airflow. Each filter shall consist of pockets of high density, microfine glass fiber media, laminated to a nonwoven synthetic backing to form a lofted surface for maximum dust holding capacity, sealed to an enclosing frame (header) of not less than 26 gauge formed galvanized steel. The configuration of the pockets shall be controlled by progressive link stitching so that uniform velocities are maintained in the air passages through the filter. Stapling of media will not be acceptable. All stitching points shall be sealed with a hot melt adhesive. Net effective filter area shall be at least 22.5 square feet per 1.0 square feet of filter face area. Filter efficiency shall average not less than (50 to 55%) (80 to 85%) (90 to 95%) when tested in accordance with ASHRAE Test Standard 52-76. Initial clean resistance shall not exceed (0.29) (0.39) (0.48) inch w.g. at 500 fpm face velocity. The 24" x 24" filters shall be certified to have a dust holding capacity of not less than (740) (480) (325) grams of ASHRAE Test Dust when operated at 500 fpm face velocity to a final resistance of 1" w.g.

G. Type "F": Ultra High Efficiency: Filters shall be individually tested, certified and labeled to have an efficiency of not less than 99.97% when challenged with diocytlphthalate smoke consisting of uniform particles of 0.3 micron size. Test procedure shall conform to the latest revision of MIL-STD-282. The 24" x 24" x 11-1/2" deep size shall be rated at an air flow of not less than (2,000) (1,200) cfm at an initial clean resistance of not more than 1" w.g. Performance data, including penetration and air friction values, shall be stated on a nameplate affixed to the exterior of the frame of each filter. The filter element shall be constructed by pleating a continuous sheet of molded, waterproof, all glass medium with interleaved corrugated aluminum separators. The filter medium shall be manufactured in accordance with the latest revision of MIL-F-51079. The filter element shall be permanently bonded to a 3/4" (three fourth inch) thick fire retardant plywood frame with a rubber base sealant.

H. Type "G": Activated Carbon Absorbent: Filters are to be furnished as all welded, factory fabricated, 16-gauge galvanized steel side access housings containing the required quantity of filter panels holding coconut shell or petroleum base carbon. The carbon used to fill the panels shall have a minimum CC14 activity of 60 minutes, a maximum ash content of 3.5%, and a maximum moisture content of 2%. Filter panels shall be 1" deep, field refillable, fabricated of polystyrene plastic or 304 stainless steel to withstand the corrosive effect of the carbon as it becomes saturated with gases, in sufficient quantity to provide not less than 45 lbs. of dry activated carbon for each 1,000 cfm of system design air volume. Panels shall slide in place in anodized aluminum tracks. Access door gasketing shall consist of strips of closed cell neoprene around the perimeter and 1" thick sheets of polyurethane opposite the ends of the panels. Housings shall include prepunched standing flanges for ease of attachment to adjacent equipment or ductwork.

2.4 HOUSINGS AND FRAMES

A. Side access housings shall be fabricated of not less than 16 gauge galvanized steel. Housings shall each be equipped with hinged access doors at both ends, provision for receiving filters of any manufacturer without alteration to the housings, and extruded aluminum channels capable of receiving both the after filters and 2" deep panel type prefilters. The housings shall incorporate a permanent provision for sealing the filters against leakage around the entire perimeter of each filter, eliminating the need to purchase replacement filters with factory applied gasket strips.

Replaceable woven pile seals shall be an integral component of the downstream flange of each extrusion so that the seals are compressed by the pressure drop across the filters, preventing bypass of unfiltered air. Side access housing shall not exceed (12) (21) inches in direction of air flow and shall be of all welded construction with factory prepunched standing flanges for ease of attachment to adjacent equipment and/or ductwork. Doors are to be fitted with positive sealing, heavy duty multiple latches and with sponge neoprene gaskets.

B. Unitary front access holding frames shall be fabricated of not less than 16-gauge galvanized steel with holes pre-punched for convenient assembly into banks. Frames shall be a minimum of 2-5/8" deep for maximum structural strength and resistance to racking. All joints in the field-assembled banks of frames shall be thoroughly caulked to prevent bypass of unfiltered air between frames and surrounding ductwork or plenum chambers. Frames shall each be fitted with polyurethane foam gaskets, held in place by long lasting adhesive, and with a minimum of four heavy-duty spring type fasteners. Fasteners shall attach to the frames without requiring tools and shall be capable of withstanding 25 pounds of pressure without deflection.

2.5 FILTER GAUGES

A. Each individual filter or filter bank handling 2,000 cfm or more shall be equipped with a diaphragm actuated dial and pointer type gauge with zero adjustment capability. The range of the scale shall be no greater than 1" w.g. above the filter manufacturer's recommended final resistance for the type of filter to which the gauge is being applied. Each gauge shall be provided with an adjustable signal flag, two static pressure tips with compression fittings, two three-way vent valves with compression fittings, two lengths of aluminum tubing, and a mounting plate with screws.

B. Provide dry contact switch to indicate high-pressure limit (adjustable) for connection by others to FCMS system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

1. Type "A" - Permanent Washable: Install one set at startup. Clean and recoat filters with adhesive as required prior to final acceptance. At final acceptance, remove and install second set. Wash and recoat first set and turn over to Owner.

2. Type "B" - Sectional, Renewable Media: Install set of pads at startup. Replace filter pads as required prior to final test and balance. At final test and balance, remove and discard the partially used pads and install a new set. Furnish Owner with one additional set of clean filter pads.

3. Type "C" - Replaceable, Dry Type, Moderate Efficiency: Install 2" deep fiberglass throwaway filters at startup. Replace throwaway filters as required prior to final acceptance. At final acceptance, remove and discard the partially used throwaway filters and install a set of moderate efficiency filters. Furnish Owner with an additional set of unused moderate efficiency filters.

4. Types "D" and "E" - Replaceable, Dry Type, Medium and/or High Efficiency: Install 2" (two inch) deep fiberglass throwaway filters at startup. Replace throwaway filters as required prior to final acceptance. At final acceptance, remove and dispose of the used throwaway filters. Install first set of medium and/or high efficiency filters and, where called for, required prefilters. Furnish Owner with an additional set of unused medium and/or high efficiency filters.

5. Type "F" - Ultra high Efficiency Filters: Install Ultra High Efficiency Filters at startup. Where Ultra High Efficiency filters are used in a system with prefilters, temporary filters shall not be used for prefilters and all specified filters must be in place at all times during system operation. Maintain filters as otherwise specified for temporary filters.

6. Type "G" - Activated Carbon Absorbent Filters: Install artificial means of simulating carbon filter air friction at startup. Activated carbon filter panels are to be stored in sealed, moisture proof, plastic bags until system is ready for final acceptance. At final acceptance, remove artificial air friction loss device and install carbon filter panels. Furnish Owner with a sufficient quantity of spare carbon filter panels, sealed in moisture proof plastic bags, to replace the largest system.

B. Install in conformance with UL 900.

C. Assemble high-pressure units by bolting sections together.

END OF SECTION 23 41 00

SECTION 23 64 26 - ROTARY-SCREW WATER CHILLERS

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. Packaged, air-cooled chillers.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.

E. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than ARI standard rating conditions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

   1. Performance at ARI standard conditions and at conditions indicated.
   2. Performance at ARI standard unloading conditions.
   3. Minimum evaporator flow rate.
   4. Refrigerant capacity of chiller.
   5. Oil capacity of chiller.
   6. Fluid capacity of evaporator.
   7. Minimum entering condenser-air temperature.
   8. Maximum entering condenser-air temperature.

9. Performance at varying capacities with constant-design entering condenser-air temperature. Repeat performance at varying capacities for different entering condenser-air temperatures from design to minimum in 10 deg F increments.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor 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. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Source quality-control reports.

D. Startup service reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 certification program(s).

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. ASME Compliance: Fabricate and label chiller to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, and include an ASME U-stamp and nameplate certifying compliance.

E. Comply with NFPA 70.

F. Comply with requirements of UL and include label by a qualified testing agency showing compliance.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

B. Ship each oil-lubricated chiller with a full charge of oil.

1. Ship oil factory installed in chiller.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Parts and labor.
c. Loss of refrigerant charge for any reason.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED, AIR-COOLED CHILLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation.
2. Trane.
3. YORK International Corporation.

B. Description: Factory-assembled and run-tested chiller complete with base and frame, condenser casing, compressors, compressor motors and motor controllers, evaporator, condenser coils, condenser fans and motors, electrical power, controls, and accessories.

C. Cabinet:

1. Base: Galvanized-steel base extending the perimeter of chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported by base.
3. Casing: Galvanized steel.
4. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B 117.
5. Sound-reduction package designed to reduce sound level without affecting performance and consisting of the following:

    a. Acoustic enclosure around compressors.
    b. Reduced-speed fans with acoustic treatment.

6. Security Package: Provide removable louvered panels with fasteners for additional protection of compressors, evaporator, and condenser coils without inhibiting service access. Finish to match cabinet.

D. Compressors:

1. Description: Semi-hermetic screw
2. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
3. Rotors: Manufacturer's standard one- or two-rotor design.
4. Each compressor provided with suction and discharge shutoff valves, crankcase oil heater, and suction strainer.

E. Service: Easily accessible for inspection and service.

F. Capacity Control: On-off compressor cycling and modulating slide-valve assembly or port unloaders combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Air Unloading Requirements over Operating Range: Drop-in entering condenser-air temperature of 5 deg F drop for each 10 percent in capacity reduction.
4. For units equipped with a variable frequency controller, capacity control shall be both "valveless" and "stepless," requiring no slide valve or capacity-control valve(s) to operate at reduced capacity.

G. Oil Lubrication System: Consisting of pump if required, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, shutdown, and standby conditions including power failure.
2. Thermostatically controlled oil heater properly sized to remove refrigerant from oil.
3. Factory-installed and pressure-tested piping with isolation valves and accessories.
4. Oil compatible with refrigerant and chiller components.
5. Positive visual indication of oil level.

H. Vibration Control:

1. Vibration Balance: Balance chiller compressors and drive assemblies to provide a precision balance that is free of noticeable vibration over the entire operating range.

a. Overspeed Test: 25 percent above design operating speed.

2. Isolation: Mount individual compressors on vibration isolators.

I. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
2. High-torque, induction type with inherent thermal-overload protection on each phase.

J. Compressor Motor Controllers:
1. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition or solid state.
2. Variable Frequency Controller:

a. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.
b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
c. Enclosure: Unit mounted, NEMA 250, Type 3R, with hinged full-front access door with lock and key.
d. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 42,000 A.
e. Technology: Pulse width modulated (PWM) output suitable for constant or variable torque loads.
f. Motor current at start shall not exceed the rated load amperes, providing no electrical inrush.

K. Refrigerant Circuits:

1. Refrigerant: Type as indicated on Drawings.
2. Refrigerant Type: R-134a . Classified as Safety Group A1 according to ASHRAE 34.
3. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
4. Refrigerant Circuit: Each shall include an electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
5. Pressure Relief Device:

a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
b. ASME-rated, spring-loaded pressure relief valve; single- or multiple-reseating type.

L. Evaporator:

1. Description: Shell-and-tube design.

a. Direct-expansion (DX) type with fluid flowing through the shell, and refrigerant flowing through the tubes within the shell.
b. Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell.

2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads located at each end of the tube bundle.
5. Fluid Nozzles: Terminated with mechanical-coupling end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
7. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.

M. Air-Cooled Condenser:

1. Plate-fin coil or all-aluminum microchannel with integral subcooling on each circuit, rated at 375 psig.

    a. Construct coil casing of galvanized or stainless steel.
    b. Construct coils of copper tubes mechanically bonded to aluminum fins.
    c. Coat coils with a baked-epoxy, corrosion-resistant coating after fabrication.
    d. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

2. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
3. Fan Motors: Totally enclosed nonventilating (TENV) or totally enclosed air over (TEAO) enclosure, with permanently lubricated bearings. Equip each motor with overload protection integral to either the motor or chiller controls.
4. Fan Guards: Steel safety guards with corrosion-resistant coating.

N. Electrical Power:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point, field-power connection to chiller.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Install factory wiring outside of an enclosure in a raceway.
5. Field-power interface shall be to NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

    a. Disconnect means shall be interlocked with door operation.
    b. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 100,000 A.

6. Provide branch power circuit to each motor and to controls with one of the following disconnecting means:

    a. 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.
    b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

7. Provide each motor with overcurrent protection.
8. Overload relay sized according to UL 1995 or an integral component of chiller control microprocessor.
9. Phase-Failure and Undervoltage Relays: Solid-state sensing with adjustable settings.

10. Provide power factor correction capacitors to correct power factor to 0.90 at full load.
11. Control Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

    a. Power unit-mounted controls where indicated.
    b. Power unit-mounted, ground fault interrupt (GFI) duplex receptacle.

12. Control Relays: Auxiliary and adjustable time-delay relays.
13. For chiller electrical power supply, indicate the following:

    a. Current and phase to phase for all three phases.
    b. Voltage, phase to phase, and phase to neutral for all three phases.
    c. Three-phase real power (kilowatts).
    d. Three-phase reactive power (kilovolt amperes reactive).
    e. Power factor.
    f. Running log of total power versus time (kilowatt-hours).
    g. Fault log, with time and date of each.

O. Controls:

1. Standalone and microprocessor based.
2. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure.
3. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units, display the following information:

    a. Date and time.
    b. Operating or alarm status.
    c. Operating hours.
    d. Outdoor-air temperature if required for chilled-water reset.
    e. Temperature and pressure of operating set points.
    f. Entering and leaving temperatures of chilled water.
    g. Refrigerant pressures in evaporator and condenser.
    h. Saturation temperature in evaporator and condenser.
    i. No cooling load condition.
    j. Elapsed time meter (compressor run status).
    k. Antirecycling timer status.
    l. Percent of maximum motor amperage.
    m. Current-limit set point.
    n. Number of compressor starts.

4. Control Functions:

    a. Manual or automatic startup and shutdown time schedule.
    b. Entering and leaving chilled-water temperatures, control set points, and motor load limits.
    c. Current limit and demand limit.
    d. External chiller emergency stop.
    e. Antirecycling timer.
    f. Automatic lead-lag switching.
    g. Variable evaporator flow.

5. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.
b. Low chilled-water temperature.
c. Refrigerant high pressure.
d. High or low oil pressure.
e. High oil temperature.
f. Loss of chilled-water flow.
g. Control device failure.

6. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.
7. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.
8. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.
9. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

a. Hardwired Points:

1) Monitoring: On-off status, common trouble alarm
2) Control: On-off operation, chilled-water, discharge temperature set-point adjustment

b. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS. Interface with existing or proposed building control system.

P. Insulation:

1. Material: Closed-cell, thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
2. Thickness: 3/4 inch.
3. Factory-applied insulation over cold surfaces of chiller components.

a. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface. Seal seams and joints.

4. Apply protective coating to exposed surfaces of insulation to protect insulation from weather.

Q. Accessories:

1. Factory-furnished, chilled-water flow switches for field installation.
2. Individual compressor suction and discharge pressure gages with shutoff valves for each refrigerant circuit.
3. Factory-furnished neoprene isolators for field installation.
4. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

2.2 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

B. Factory run test each air-cooled chiller with water flowing through evaporator.

C. For chillers located outdoors, rate sound power level according to ARI 370.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting: Install chiller using elastomeric pads. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration Isolation."

1. Minimum Deflection: 1/4 inch.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge chiller with refrigerant and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232100 "Hydronic Piping," Section 230620 Hydronic Piping Specialties". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve,flexible connector, flow switch, thermometer, plugged tee

with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a flange or mechanical coupling.

3.4 STARTUP SERVICE

A. Engage an authorized factory employee to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
9. Verify and record performance of fluid flow and low-temperature interlocks for evaporator.
10. Verify and record performance of chiller protection devices.
11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions.

END OF SECTION 23 64 26

SECTION 23 73 23 – AIR HANDLING UNITS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

C. Air Handling Units

D. Factory Installed Fans

E. Dampers

F. Filters

G. Coils

H. Drives

I. Humidifiers

1.3 RELATED SECTIONS

A. Section 23 05 48 - Vibration Isolation

B. Section 22 13 16 - Plumbing Piping: Equipment Drains

C. Section 23 05 13.- Motors

D. Section 23 05 16 - Expansion Compensation

E. Section 23 07 13 - Ductwork Insulation

F. Section 23 29 23 – Variable Frequency Drives

G. Section 23 31 00 - Ductwork

H. Section 23 33 00 - Ductwork Accessories: Flexible Duct Connections

I. Section 23 34 16 - Fans

J. Section 23 41 00 - Filters

K. Section 23 82 16 - Air Coils

L. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

M. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings

C. AMCA 99 – Standards Handbook.

D. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.

E. AMCA 300 – Test Code for Sound Rating Air Moving Devices.

F. AMCA 301 – Method of Publishing Sound Ratings for Air Moving Devices.

G. AMCA 500 – Test Methods for Louver, Dampers, and Shutters.

H. ARI 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment

I. ARI 410 – Forced Circulation Air Cooling and Air Heating Coils.

J. ARI 430 – Standard for Central Station Air Handling Units.

K. ARI 435 – Application for Central Station Air-Handling Units.

L. ARI 610 – Central System Humidifiers.

M. NEMA MG1 – Motors and Generators.

N. NFPA 70 – National Electrical Code.

O. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.

P. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for use in Air-Handling Spaces.

Q. SMACNA – HVAC Duct Construction Standards Metal and Flexible.

R. UL 900 – Test Performance of Air Filter Units.

S. ANSI/ASHRAE/IESNA Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Include with the initial submittal a letter signed by the manufacturer's national sales manager (or any corporate officer) and the production manager, acknowledging that this equipment is intended for a University of Texas facility and that all specification requirements shall be complied with. Submit copy of letter to OFPC engineer.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics, connection requirements, and.

D. Product Data and Record Documents:

1. Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, gages and finishes of materials, electrical characteristics and connection requirements. Refer to detailed list of submittal data in this Section.
2. Provide data of filter media, filter performance data, filter assembly, and filter frames as tested and certified per ASHRAE 52.2 and UL-900 class 1.
3. Provide fan curves with specified operating point clearly plotted, as tested and certified per AMCA standards (refer to fan array section for AMCA requirements on fan arrays). Ratings to include system effects inside the air handling units. Bare fan ratings will not satisfy this requirement, but shall be submitted for comparison purposes. All fan data shall be generated from specified testing..
4. Submit sound power level data for both fan outlet and casing radiation at rated capacity, as tested and certified per AMCA and ARI 260 standards. All fan data shall be generated from specified testing.
5. Provide data on all coils as tested and certified per ARI standards.
6. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.
7. All electrical power, lighting, control, sensor, and pressure taps, and TAB access ports are to be noted on the submittal Drawings. Wiring shall have smoke and flammability of 25/50 or better per test method of NFPA 262. Note that the liquid tight flexible metal conduit connections to the fan motor are exempt from this portion of the specification.
8. Note each deviation and reason for the deviation on the shop drawing submittal.

E. Operation and Maintenance Data:

1. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
2. Provide Operating and Maintenance (O&M) Manuals for air handling units.
3. Manufacturer's Instructions: Provide Start-up information and maintenance required prior to Start-up. Coordinate with Division 01, 20, and 26 Commissioning Specifications.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience, who issues complete catalog data on total product.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Protect openings in casing and seal them with plastic wrap to keep out dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

E. Air handling units are not to be used for storage of construction materials under any circumstance.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation of the Owner's RCM.

1.9 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two sets of belts and three sets of filters for each unit. One set of filters is to be installed when unit is started up, and shall be protected from construction debris with additional media either at the first bank of filters, or covering each air intake (outside air and return air). The second set of filters is to be installed when test and balance activities begin. At substantial completion, OFPC RCM shall inspect filters to determine if the third set should be installed or delivered to campus operations personnel. Tag to identify associated unit.

1.10 SCHEDULES ON DRAWINGS:

A. In general, all capacities of equipment, and motor and starter characteristics are shown in schedules on the drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Fan motor horsepower (unless noted otherwise) is maximum horsepower. Fan brake horsepower cannot be exceeded per scheduled maximum BHP. Variations in the capacities of the scheduled equipment supplied under this contract will be permitted only with the written direction of the owner.

B. Where installation instructions are not included in these specifications or on the drawings, the manufacturer's instructions shall be followed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Climate Craft

B. Haakon

C. Temtrol

D. Air Enterprises

E. Energy Labs

F. Thermal Corporation

G. Substitutions: Under provisions of Section 23 00 00. The equipment as supplied by any of the acceptable manufacturers or an approved equal shall comply with all of the provisions of this specification.

2.2 GENERAL DESCRIPTION

A. Configuration: Unit Configuration is indicated on the drawings and may vary from unit to unit.

B. Performance Base: Sea level conditions

C. Fabrication: Conform to AMCA 99 and ARI 430 in the absence of direction in this specification.

D. Performance: Refer to schedule in drawings.

2.3 AIR HANDLER CASING AND GENERAL CONSTRUCTION:

A. Unit casing exterior (walls and roof) shall be a minimum 18-gauge thickness galvanized steel insulated internally, throughout (double wall construction with no thru metal). Internal insulation shall have an R-value of at least 10. All internal insulation shall be protected with solid galvanized sheet metal, of a minimum of 20-gauge thickness (note that fan sections may be lined with a perforated metal liner if this is indicated elsewhere in the specifications or the contract drawings). All sheet metal joints throughout the air handler, and between panelized sections, shall be gasketed with closed cell, soft rubber gaskets, fabricated from neoprene, EPDM, or other approved material. Internal walls and roof outside shall be sealed such that there is no passage

B. Casing assembly shall be configured to eliminate all thru-metal in portions of the unit subject to below ambient temperatures. Where fasteners are used in the assembly of the unit components, they shall not extend from the outside of the unit into the air stream.

C. Drain pan liners shall be constructed of No. 14-gauge 316-L stainless steel or heavier as standard with the manufacturer and shall be non-skid. Drain pan shall extend past the cooling coil in the direction of airflow by a minimum of 18”. Entire drain pan shall be insulated with R-8 rigid insulation. Drain pans shall be sloped to the outside edge of the unit. On units over six feet wide, slope to each side of the unit. The insulation shall be installed and sealed as is appropriate for the equipment construction.

D. Unit shall have a complete perimeter channel base of at least 6" galvanized steel or 6” carbon steel with marine quality primer. All floors shall be insulated with R-10 insulation with 14-gauge non-skid galvanized floor (or equivalent aluminum). An 18-gauge galvanized sheet shall enclose and form a vapor barrier for the insulation on the bottom of the unit. All points of contact between the floor, vapor barrier and structure shall be thermally isolated with gasketing of closed cell soft rubber or EPDM.

E. Access doors shall be provided to allow access upstream and downstream of the filter racks, the fan section, and coils. Access doors shall be double wall, insulated the same as wall panels, and the opening framed with thermal break construction. Door size shall be at least 18” wide (inside free and clear dimension) and full height of the panel (minus allowance for framing and panel support) up to 80” tall. The construction of the access doors shall equal or exceed the quality and quantity of the air handler casing materials as specified herein. Each door shall have a minimum of an 8-inch by 6-inch double-glazed view window, capable of withstanding the total developed pressure of the unit. The doors shall be hinged using either heavy-duty stainless butt hinges, or a continuous stainless steel piano hinge, extending along the entire edge of the door, except for a maximum of two inches at each end. If butt hinges are used, provide two per door for up to 36” high doors and three per door for longer doors. There shall be a minimum of two latches on doors

longer than 18," and three latches in doors over 36" long. Latches shall be Ventlok 310, heavy-duty latch, or approved equal. All access doors shall open against air pressure.

1. Access doors for the fan section must be large enough to allow removal of fan (s) without cutting the fan or base into pieces.

2. Provide on access doors to fan section a door switch to turn off power to the fan motor.

F. Coils in the air-handling units shall be individually removable and shall not be used to provide structural stability for the casing. All coils shall be arranged for and piped to provide counterflow operation. All coil frames shall be fabricated of 316 L stainless steel. The coils shall be completely enclosed within the coil housing of the air unit casing. All penetrations of the air handler casing shall be neatly sealed using a resilient sealant or tight fitting rubber grommet. Stacked coils shall have intermediate drain pans extending no less than 12" in the direction of airflow with at least 1" rigid drain piping and pipe supports to main drain pan. Stacked coils shall be constructed with a blank off plate between upper and lower coils to eliminate coil bypass air from contacting intermediate drain pan.

G. Panels shall be reinforced with sufficient internal bracing to prevent excessive deflection of the panels. Maximum deflection of the unit casing shall be limited to L/250th of the largest overall panel dimension. Refer to deflection testing requirements in Section 3 of this specification.

H. Panel construction shall provide the following acoustical performance.

1. Sound Transmission Loss (dB) per ASTM E-90 & E-4130

Octave	2	3	4	5	6	7	STC+
Coated Liner	22	26	37	44	53	55	39
Solid Liner	22	38	49	50	57	62	42

2. Sound Absorption Coefficients per ASTM C-423 & E-795

Octave	2	3	4	5	6	7	NRC+
No liner	.26	.71	1.09	1.02	.96	.83	.95
Coated Liner	.25	.79	1.06	1.06	1.04	.78	1.00

The above ratings represent minimum performance. Unit manufacturer shall submit full sound performance per the requirements of Section 1 of this specification.

I. Provide a unit housing, including joints, seams, and access doors, that will not condense moisture on the external surfaces of this housing when subjected to a surrounding ambient environment of 82 ^{o}F dry-bulb/75 ^{o}F dew-point temperature air with chilled water temperatures of 40 ^{o}F and a discharge air temperature of 50 ^{o}F.

J. Equivalent aluminum material may be used where galvanized steel panel components are called for.

K. Provide sealable test ports on either side of each filter bank and each coil section, in inlet plenum and discharge plenum, and suction and discharge side of all fans. Ports shall be equal to Ventfabrics test port Model 699-2.

2.4 FANS (SEE ALSO SECTION 23 34 16)

A. Shall be both dynamically and statically balanced. Housed fans shall be equipped with quick opening access doors in the fan scroll. The motor mounting for each unit shall be an integral part of the fan support frame. The fan/motor unit shall be mounted on spring isolators within the air handler casing. Housed fans shall have an appropriately designed fabric duct vibration isolator installed within the air handler casing. The unit shall be supplied with a factory installed and sealed flange for connection to ductwork. For belt drive units, manufacturer shall provide fixed sheave on units of 10 HP and larger. Contractor shall provide one additional sheave set, size to be determined after job-operating conditions are known. The additional sheave set shall be of equivalent quality to that originally installed by the manufacturer.

B. The fan unit bearings shall be of the antifriction type, either ball or roller, lubricated at the factory, and shall be equipped with means for lubrication with a grease fitting on the outside of the bearing housing. Both inboard and outboard bearings shall be the same, identical size. The bearings shall be a catalogued type as manufactured by Fafnir, SKF, Sealmaster, or approved equal, and stocked locally. Bearings shall have an L-10 minimum life of 200,000 hours. Intermediate bearings will not be acceptable. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where it is not possible, then the fitting shall be mounted where it is most easily accessible for service. The tubing used for remoting the fitting shall be stainless steel, installed with a strain relief pigtail approximately 4 inches in diameter and located on the drive side of the assembly.

C. After assembly, the unit manufacturer shall balance the fan (per ANSI/AMCA 204-96 fan application category BV-3) at design fan speed with belts and drives in place to a vibration velocity less than or equal to 0.157 inches (0.100 inches for direct-drive applications) per second measured on horizontal, vertical, and axial planes at each bearing pad. Vibration amplitudes are in inches/second peak velocity. All values recorded are to be filter-in at the fan speed.

D. Plug fans installed in walk-in units shall be provided with a safety cage around the wheel or with a fan shut down switch in the access door. Cage shall be large enough to allow working room for wheel and bearing service and shall have removable sections to allow wheel removal.

E. Fans shall be selected at a maximum of 1800 RPM and a maximum motor speed of 60 Hz unless specifically scheduled otherwise.

F. Fans shall be selected to operate outside of the surge line with a variance of up to 20% of TSP.

2.5 DAMPERS

A. All automatic control dampers and manual volume control dampers located within the air handling unit or at the air opening on the air handling unit shall be furnished by AHU manufacturer.

1. The actuators for the dampers shall be furnished by the Building Automation Contractor.

B. Mixing Boxes: Section with factory built, factory mounted outside and return air dampers of aluminum or stainless steel and edge seals in aluminum or stainless steel frame, with aluminum or stainless steel axles in self-lubricating nylon bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension. Provide removable, full width rack for supporting freeze protection thermostat, with removable end panel to permit rack removal.

C. Damper Leakage: Maximum 4 CFM/Sq. Ft. at 4 inch WG differential pressure. Dampers shall be sized for 2000 fpm maximum face velocity or the same size as the duct connection where one is present.

D. Refer to Section 23 33 00-2.01 for additional requirements.

2.6 DRIVES

A. V-belt drives: Shall be designed for a minimum of 50% overload. Where more than one belt is required, matched sets shall be used. All belt drives shall be furnished with belt guards.

B. Variable frequency drives: See Section 23 29 23.

2.7 COILS

A. Refer to Section 23 82 16 - Air Coils, and Unit Schedules for requirements.

2.8 FILTERS

A. Refer to Section 23 41 00 - Filters, and Unit Schedules for requirements.

2.9 HUMIDIFIER

A. Refer to Section 23 84 13 Steam Grid Humidifiers.

2.10 MOTOR

A. Motors shall be inverter duty, high efficiency type per Section 23 05 13. See Section 23 05 13 for additional requirements.

2.11 ELECTRICAL

A. Fan motors shall be interlocked with fan access door to shut down when door is opened.

1. Refer to Multiple Fan Section for specific fan requirements

B. Fan motors shall be factory mounted and wired to an external disconnect switch adjacent to the motor access door.

C. Vapor proof lights (ceiling or wall mounted so that fixture shall be no higher than 88” above floor) shall be provided in each compartment with access doors. Lights shall have a switch at each door into the compartment. Provide two GFI convenience outlets evenly spaced on the long dimension of the unit. Wire lights and outlets to two external 120v, 20a power connections (one for each service) for connection by Division 26.

D. All wiring shall be 600v rated type MTW/THWN stranded copper in EMT or LiquidTite conduit (max 3 feet). All junction boxes shall be UL approved and gasketed.

2.12 FINISH

A. All external parts of the unit shall be Brite G-90 galvanized. No painting will be required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field assembly of the unit shall be the responsibility of the manufacturer.

B. Install in conformance with ARI 435.

1. Assemble high-pressure units by bolting sections together. Isolate fan section with flexible duct connections for units equipped with housed fans
2. Unit shall be installed level and plumb. Where units are installed on a concrete housekeeping pad, units shall be installed on neoprene pads as indicated on installation details and in Section 23 05 48 - Vibration Isolation.
3. Piping and duct connections shall be installed so that all access doors swing freely.

3.2 TESTING

A. Units with cabinet mounted fans shall be tested and certified at rated conditions using AMCA 210 and AMCA 300 test procedures with fan mounted in the cabinet. Bare fan data will not be accepted.

B. Travel costs (airfare, meals, lodging, ground transportation) for the Owner's TAB consultant to witness tests shall be paid by the manufacturer.

C. Casing Deflection Test

1. Deflection limit of L/250 shall be demonstrated in the factory prior to shipping and witnessed by a representative of the Owner's Test and Balance Consultant.
2. 'L' is defined as the height of the largest panel on the sides, width across the top of the largest panel on the unit, and the smaller of width or height of the largest panel for the ends. These are known as the governing panels.
3. That portion of the unit after the fan discharge shall be tested at positive pressure. The remainder of the unit shall be tested at negative pressure.
4. Measurements shall be taken at midpoint of 'L' using dial indicators reading in 1/1000ths. Mounting of dial indicators shall be independent of the unit casing. Multiple measurements shall be made. Dial indicator shall be mounted at midpoint of 'L'. Measurements shall then be spaced along the sides, ends and top at mid point and quarter points of the negative section and the positive section. Spacing shall be adjusted to fall on nearest flange or panel joint. Any section of less than five feet shall require only one measurement at the center.
5. Unit shall be furnished with proper blank offs to facilitate the pressure testing.
6. In order to reduce the number of pressure cycles, it is recommended that multiple dial indicators be used at the measurement points. Separate set-ups will be required for the positive pressure tests and the negative pressure tests.

D. Casing Leakage Test. With unit set in place, leveled and ready to receive duct work connections after delivery [on-site], unit shall be tested for casing leakage by sealing all openings and pressurizing to 2.5 times rated pressure (defined as total static pressure of unit) or 10" WG, whichever is smaller. Maximum allowable leakage rate is 1.5% of rated unit flow. Test is to be performed using flow measurement devices and shall be witnessed by a representative of the Owner's Test & Balance firm.

E. Fan/Motor Vibration Test. With the unit set in place, leveled, and ductwork attached, the manufacturer shall perform a final dynamic vibration trim balance to verify the fan/motor vibration velocity limit over the following operating speed range: Fans with VFDs shall be checked by operating at VFD speeds from 20 to 65 Hz. Constant speed fans shall be checked at 100% of rated fan speed. 'Lock-out' ranges may be used to correct up to three ranges of excess vibration. The span of each 'lock-out' range shall be limited to an effective fan speed of 50 RPM. Any 'lock-out' range used shall be clearly identified in the test report and shall be prominently displayed on

a typed, laminated legend mounted inside the VFD controller cabinet. This testing shall be witnessed by a representative of the Owner's Test and Balance firm.

1. Note that for air handling units equipped with multiple fans, each fan shall be tested individually and the fan array shall be tested as an assembly.

F. Failure of the leakage and/or deflection test shall require sealing and bracing of the unit and retesting until criteria is met. Failure of the trim balance to confirm vibration limit shall require rebalancing and re-testing until criteria is met. Contractor shall bear all costs involved in the modifications, balancing, and re-testing, including travel and hourly costs associated with the representatives of the Owner's Test and Balance firm.

3.3 FINAL CLEANING AND PREPARATION

A. Prior to substantial completion, contractor will clean and prepare the unit for acceptance by the owner by doing the following:

1. Wipe down and clean the unit inside and outside. The unit shall be free of dirt, dust, foot prints, paint splatter, etc.
2. All coils shall be combed to straighten any bent fins.
3. Filters that were used in the construction phase shall be replaced with new filters.
4. All penetrations made in the unit cabinet (power, controls, tab, etc) shall be sealed air tight.
5. Any devices that require lubrication, tensioning, etc shall be serviced.

END OF SECTION 23 73 23

SECTION 23 81 26 – DUCT LESS SPLIT-SYSTEM AIR-CONDITIONING UNITS

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 this Section.

1.2 SUMMARY

A. This Section includes duct less split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed mounting, and include the following type of units:
   1. Wall mounted units (high-wall).

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
B. 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.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion on compressors.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Air Conditioning.
   2. EMI.
   3. McQuay Air Conditioning.
   4. Trane Company.
   5. York International.
   6. Daikin

2.2 EVAPORATOR-FAN COMPONENTS (HIGH WALL)

A. Cabinet: Enameled steel with removable panels on front and ends in manufacturer standard color. Discharge and inlet grilles shall be attractively styled, high-impact polystyrene.
   1. Insulation: 1" high density, R 4.2.
   2. Drain Pans: Galvanized steel with anti-corrosion coating.
   3. Provide with factory mounted condensed pump.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: 3-speed direct drive Centrifugal, FC.

D. Fan Motors: Manufacture standard with overload protection.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Galvanized steel, finished with baked enamel in manufacturer-standard color, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Scroll.
   2. Rubber vibration isolator mounting.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240.

D. Fan: Propeller type, directly connected to motor.

E. Motor: Permanently lubricated, totally enclosed with integral thermal-overload protection

F. Refrigerant: R-410A.

2.4 ACCESSORIES

A. Thermostat: Low voltage 7-day subbase to control compressor and evaporator fan.
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection, including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Condensate Pump, field or factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounting, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounting compressor-condenser components on raised, supports built-in cant equipment equal to RPS ER Series. Anchor units to supports with removable, cadmium-plated fasteners.

F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 15 Section "Mechanical Vibration Controls."

G. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION

SECTION 23 82 16 – AIR COILS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES

A. Water coils

B. Glycol coils

C. Refrigerant coils

D. Electric coils

1.3 RELATED SECTIONS

A. Section 23 07 19 - Piping Insulation

B. Section 23 06 20.13 - Hydronic Specialties

C. Section 23 31 00 - Ductwork: Installation of duct coils

D. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt

E. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 REFERENCES

A. ANSI/ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils

B. ANSI/NFPA 70 - National Electrical Code

C. ANSI/UL 1096 - Electric Central Air Heating Equipment

D. SMACNA - HVAC Duct Construction Standards, Metal and Flexible

1.5 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating:

1. heat transfer quantities
2. inlet and outlet conditions of air and heat transfer medium
3. pressure drop and flow information
4. minimum air flow (if applicable)
5. minimum water flow (if applicable)
6. velocity of heat transfer medium through coil
7. wiring diagrams and control drawings for electrical heating coils
8. materials, circuiting and configuration

E. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

F. Submit manufacturer's certificate under provisions of Section 23 00 00that coils are tested and rated in accordance with ANSI/ARI 410.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.

D. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 - PRODUCTS

2.1 WATER COILS:

A. Water coil capacities, pressure drops and selection procedures shall be certified for the capacity scheduled in accordance with ARI Standard 410. Non-certified coils will not be accepted.

B. Chilled water, hot water, and glycol coils shall be of the extended surface type meeting all conditions and having the pressure drops scheduled on the Drawings, and shall have same-end supply and return connections unless otherwise indicated. Coils shall be constructed of copper

tubes 5/8" O.D. with .035" thick minimum wall thickness and copper fins for chilled water and aluminum fins for heating water, permanently bonded to the tubes by mechanical expansion. Coils shall have a maximum of 8 fins per inch, and a maximum of 6 rows. If additional capacity is necessary, the additional capacity shall be provided by an additional coil, with an additional access section between the coils, and the coils shall be piped in series, counterflow to the direction of air flow. Copper fins on plate coils shall be .006" thick.

C. Coil headers and connections shall be of I.P.S. brass or heavy gauge seamless hard drawn copper tubing with penetrations for connection of core tubing by die-formed intrusion process with resulting contact depth between the header wall and core tubing of not less than .090". Joints between core tubing and header shall be of recess swage design to allow a large mating area for build up of brazing materials to give increased strength to the joint. Supply and return connection of brass or copper shall be terminated with National Pipe Threads with wrench flats Coils shall be designed and certified by the manufacturer to operate as scheduled without moisture carry over. Each coil section shall be provided with a 316-L Stainless Steel frame/casing, including tube sheets, no lighter than 16 gauge. Frame members shall extend over the ends and edges of the coils and shall be constructed with formed holes for tubes, permitting free expansion and contraction of coil sections while supported by an extended surface of the frame. Intermediate tube support sheets of 316-L stainless steel shall be provided in all coils having tube lengths in excess of 48": on long coil sections the spacing of coil supports shall not exceed 48". All intermediate supports shall be welded to coil frame members and fabricated with formed tube holes to support the penetrating tubes.

D. Pressure test all coils to 350 psi under water.

2.2 ELECTRIC COIL:

A. Manufacturers:

1. Subject to compliance with these specifications, provide electric heating coils by one of the following manufacturers:
   a. Brasch
   b. Chromalox
   c. Indeeco

B. Heaters shall be U.L. Listed for zero clearance and meet all the applicable requirements of the National Electrical Code.

C. All resistance coil terminals and nuts shall be made of stainless steel, and terminal insulators and bracket bushings shall be made of high grade ceramic and securely positioned. Resistance wire shall be iron free, 80% nickel and 20% chromium. Bracket supports for the resistance wire shall be reinforced with stiffening ribs and gussets, and spaced no more than four inches apart. Heaters shall be tested dielectrically for 1000V plus twice the rated voltage or 2000V, whichever is higher.

D. Heaters shall be furnished for volts and phases as scheduled. Three phase heaters shall be furnished with balanced three phase load. The control voltage shall be 120 volts or as scheduled and transformers with primary fuse protection shall be provided in the terminal box for each heater when the control voltage is not the same as the unit feeder voltage. .

E. Heaters shall be supplied with overcurrent protection per NEC. Overcurrent protection shall consist of one built in automatic circuit. A disc type automatic reset thermal cutout shall be furnished for primary overheating protection. Secondary protection fusible links shall be provided to de-energize the elements in case the primary cutout fails. Both devices shall be serviceable through the terminal box without having to remove the heater from the duct or air handling unit.

Provide factory mounted and wire pressure sensitive type air flow switch for each heater to allow the heater to be "on" only when sufficient air is blowing through the heater. Note that the minimum airflow velocity required for the heater to be on must be included in the submittal.

F. Heaters and protection devices shall be arranged for single point connection.

G. Duct Heaters: Electric duct heaters shall be of the flanged type and shall be suitable for mounting in a horizontal or vertical duct, and air flow through the heater in either direction. Heaters shall be made with galvanized steel frame. A terminal box shall be provided on the unit with solid cover.

1. All duct heaters shall be sized to fit the duct in which they are installed and be located at least 48" (forty-eight inches) from any turn, transition, tap, damper, or other fittings in the duct run.

H. Capacity Control: Furnish Heaters with contactors for each scheduled stage or SCR as scheduled

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

C. Support coil sections independent of piping on steel channel or double angle frames and secure to casings. Provide frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Provide airtight seal between coil and duct or casing.

D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

E. Make connections to coils with unions and flanges.

F. On water [and glycol] heating coils, and chilled water cooling coils, connect water supply to leaving air side of coil (counterflow arrangement).

G. Insulate headers located outside air flow as specified for piping. Refer to Section 23 07 19.

H. Wire electric duct coils in accordance with ANSI/NFPA 70. Refer to Sections 26 05 19 and 26 27 26.

END OF SECTION 23 82 16

SECTION 23 82 19 – TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:

A. Section 23 00 00 – Basic Mechanical Requirements

B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

C. Section 23 05 53 – Mechanical Identification

D. Section 23 82 16 – Air Coils

E. Section 23 41 00 - Filters

1.2 SECTION INCLUDES

A. Unit Heaters

B. Cabinet Unit Heaters

C. Fan Coil Units

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 09 00 - Controls and Instrumentation: Installation of Room Thermostats

1.4 RELATED SECTIONS

A. Section 23 05 13 - Motors

B. Section 23 21 00 - Hydronic Piping

C. Section 23 06 20.13 - Hydronic Specialties

D. Section 23 22 00 - Steam and Steam Condensate Piping

E. Section 23 22 00.A - Steam and Steam Condensate Specialties

F. Section 23 09 23 - Controls and Instrumentation

1.5 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code

1.6 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating cross section of cabinets, grille, bracing and reinforcing, and typical elevation.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating typical catalog of information including arrangements.

E. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

F. Indicate mechanical and electrical service locations and requirements, specifically indicating deviations from indicated products.

G. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

H. FAN SUBMITTAL DATA:

1. Submittal data for approval for all fans of every description furnished under this section of these Specifications . Submittals shall include the following:

2. Fan curves with recommended stable range of operation.

3. Fans shall be selected to operate stably at the reduced loads specified by the Engineer by means of variable speed drives or ECM Motors as scheduled.

I. FILTER SUBMITTAL DATA:

1. Submit data for approval for filters provided for each Terminal Heat Transfer Unit (identify which filters are intended for which THTU, and in what position) per the requirements of Section 23 41 00 Filters.

J. COIL SUBMITTAL DATA:

1. Submit data for approval for coils provided for each Terminal Heat Transfer Unit (identify which coils are intended for which THTU, in what position and in what order) per the requirements of Section 23 82 16 Air Coils.

1.7 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 23 00 00.

B. Accurately record actual locations of access doors for access or valving.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include manufacturer’s descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

1.10 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70 code and Underwriters Laboratories, Inc. for internal wiring of factory wired equipment.

1.11 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00.

B. Store and protect products under provisions of Section 23 00 00.

C. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.12 SEQUENCING AND SCHEDULING

A. Sequence work under the provisions of Section 23 00 00.

B. Schedule work under the provisions of Section 23 00 00.

1.13 WARRANTY

A. Provide five-year manufacturer's warranty under provisions of Section 23 00 00.

B. Warranty: Include coverage of fan-coil unit, unit heater, and unit ventilator motors and coils.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

A. Manufacturers: Subject to compliance with these specifications, provide unit heaters by one of the following manufacturers:

1. Reznor
2. Markel
3. Modine
4. Trane

B. Electrical Coils: Stainless Steel heating elements (finned above 15 kW), with air flow safety switch

C. Casing: 18 gauge steel with threaded pipe connections for hanger rods.

D. Finish: Factory applied baked enamel (color to be standard factory color selected during submittals unless scheduled otherwise) on visible surfaces of enclosure or cabinet.

E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

F. Air Outlet: Adjustable pattern diffuser on projection models and [two] [four] way louvers on horizontal throw models.

G. Motor: Refer to Section 23 05 13: horizontal models with permanently lubricated sleeve bearings, vertical models with grease-lubricated ball bearings.

H. Control: Local low voltage thermostat for remote mounting with relay for enable/disable by BAS, and factory furnished disconnect switch.

2.2 FAN COIL UNITS:

A. Manufacturers: Subject to compliance with these specifications, provide fan coils units by one of the following manufacturers:

1. Greenheck

2. IEC International Environmental

3. Temtrol

4. Thermal Corporation

B. Cabinet: Cabinet shall be double wall with exterior panels no less than 18 gauge and interior panels of no less than 22 gauge with 1" glass fiber insulation. Where scheduled or indicated on drawings, provide interior panel as a perforated liner. Cabinet to be corrosion resistant treated before final baked enamel finish is applied (units in mechanical rooms or similar spaces may be galvanized and unpainted). Unit capacities shall be certified in accordance with ARI Standard 441-66. Unit sound data shall be rated in accordance with ARI Standard 443-66. The units shall bear an ARI (Air-Conditioning & Refrigeration Institute) stamp.

C. Fan coil units shall be of the size and configuration as scheduled on the Drawings.

1. Access doors shall be provided as indicated on the drawings and shall be tool less access (twist handles with cam closure).

D. Condensate Drain Pans: Formed sections of stainless steel sheet. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) when units are operating at maximum catalogued face velocity across cooling coil.

1. Fill space between walls with 1 inch, (1-1/2) (3) pound fiber glass insulation.

2. Drain Connections: Main and auxiliary on same side of fan.

E. Fan Section Construction: Belt driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor drive assembly, and support structure and equipped with formed steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with interior (neoprene) (spring) vibration isolation.

1. Centrifugal Fan Housings: Formed and reinforced steel panels to make curved scroll housings with shaped cutoff, spun metal inlet bell, and access panels or doors to allow entry to internal parts and components.

a. Panel Bracing: Steel angle or channel iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

b. Horizontal Flanged Split Housing: Bolted construction.

F. COILS

1. Coil Sections: Common or individual, insulated, galvanized steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.

2. Water Coils: (Continuous circuit coil fabricated according to ARI 410) (Self-draining coil fabricated according to ARI 410).

a. Coil tubes shall be copper with a minimum tube thickness of 0.016 inches. Fins shall be aluminum and shall be mechanically bonded to copper tubes. Coil shall have a maximum of 10 fins per inch. Coil headers shall be made of seamless copper tube with brazed joints. Coil connections shall use sweat fittings.

b. The coil assembly shall be design tested and rated according to ARI 410. The coil shall have a working pressure of 250 psig, 300 F. The manufacturer shall perform

quality control by testing units to 500 psig underwater. Units shall have a 2000 psig ultimate strength.

c. The frame assembly shall be constructed out of galvanized steel channel.

3. Electrical Heating Coils, Controls, and Accessories: Comply with UL1995.

a. Casing Assembly: Slip in type with galvanized steel frame

b. Heating Elements: Open coil resistance wire of 80 percent nickel and 2- percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized steel frame.

c. Over-Temperature Protection: Disk type, automatically resetting thermal cutout, safety device, serviceable through terminal box without removing heater from duct or unit.

d. Secondary Protection: Load carrying, manually resetting or manually replaceable, thermal cutouts, factory wired in series with each heater stage.

G. Drive Frame: Rail mounted, heavy gauge steel to allow frame to slide for easy belt tensioning. Forward Curved Fan Wheels: Galvanized steel and/or aluminum/painted steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

H. The unit shall be controlled with a control valve as indicated in the plans, furnished by temperature control supplier and installed in the field by the Mechanical Subcontractor.

I. The unit shall have belt or direct drive fans and 1/2" throw-away filters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that required utilities are available, in proper location, and ready for use.

C. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Hang unit heaters from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

C. Install fan-coil units as indicated. Coordinate to assure correct recess size for recessed units.

D. Protect units with protective covers during balance of construction.

E. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Verify that electrical

wiring installation is in accordance with manufacturer's submittals and installation requirements of Division 26 sections.

3.3 CLEANING

A. Clean work under provisions of 23 00 00.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

D. Install new filters after Substantial Completion.

END OF SECTION 23 82 19

SECTION 26 00 00 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General Requirements specifically applicable to Division 26.

B. The Contractor shall be responsible for:

1. The work included consists of furnishing all materials, supplies, equipment and tools, and performing all labor and services necessary for installation of a completely functional power, lighting, fire alarm and signaling systems. Complete systems in accordance with the intent of Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions, which affect the work covered under this Division.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Temporary power service and lighting for construction. Coordinating all shutdown dates and schedules with Owner's Representative and obtain all work-permits required by Owner.

C. Intent of Drawings:

1. The Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every device or raceway in its exact location, unless specifically dimensioned. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceway, subject to prior review by the Owner and Engineer. Work shall be organized and 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. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

2. The intent of the Drawings is to establish the type of systems and functions, but not to set forth each item essential to the functioning of the system. The drawings and specifications are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Review pertinent drawings and adjust the work to conditions shown. In case of doubt as to work intended, or where discrepancies occur between drawings, specifications, and actual conditions, immediately notify the Architect/Engineer and the Owner’s representative, and propose a resolution.

3. Discrepancies: In case of doubt as to work intended, or if amplification or clarification is needed, or where discrepancies occur between Drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer and the Owner's Representative in writing, requesting an interpretation, and include a proposed solution.

4. Dimensions: Dimensional information related to new structures shall be taken from the appropriate Drawings. Dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

5. Outlet and Equipment Locations: Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, telecommunications, audio-visual (AV), security, plumbing, and laboratory Drawings. Review with the Owner's Representative proposed changes in outlet and

equipment location. Relocation of outlets before installation of up to 5 feet from the position indicated may be directed without additional cost to the Owner.

1.2 RELATED WORK

A. This Section shall be used in conjunction with all other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.

1.3 DESIGN CRITERIA

A. Equipment and devices to be installed outdoors or in enclosures where the temperatures are not controlled shall be capable of continuous operation under such conditions per manufacturer's requirements.

B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.

C. Electrical components shall be UL listed and labeled, or Owner approved Nationally Recognized Testing Laboratories.

1.4 REFERENCE CODES AND STANDARDS, REGULATORY REQUIREMENTS

A. Standards of the following organizations as well as those listed in Division 01, may be referenced in the specification. Unless noted otherwise, references are to standards or codes current or currently adopted at the time of bidding.

1. Association of Edison Illuminating Companies (AEIC)
2. American National Standards Institute (ANSI)
3. Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. National Electrical Code (NEC, NFPA 70)
6. National Electrical Manufacturers Association (NEMA)
7. National Fire Protection Association (NFPA)
8. Underwriter's Laboratories (UL)
9. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
10. International Energy Conservation Code (IECC)

B. Work, materials and equipment must comply with the latest rules and regulations of the following.

1. National Electrical Code (NEC)
2. Occupational Safety and Health Act (OSHA)
3. American with Disability Act (ADA)
4. American Society for Testing and Materials (ASTM)
5. University of Texas (UT) System
6. Applicable state and federal codes, ordinances and regulations

C. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the

Owner's representative in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified shown.

D. Contractor shall obtain permits and arrange inspections required by codes applicable to this Section and shall submit written evidence to the Owner and Engineer that the required permits, inspections and code requirements have been secured.

1.5 SUBMITTALS

A. Submit the following in addition to and in accordance with the requirements of Division 01 for submittal requirement.

1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of it are clearly indicated and non-applicable portions clearly deleted or crossed out.
3. All schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA.
4. Provide submittals as required by individual specification Section.

B. Provide the following with each submittal:

1. Catalog cuts with manufacturer's name clearly indicated. Applicable portions shall be circled or otherwise highlighted and non-applicable portions shall be crossed out.
2. Line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.

C. Installation:

Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by Owner's Representative. Use only equipment and materials accepted by the Architect/Engineer and by Owner's Representative. Equipment and materials installed prior to acceptance by the Owner/ Engineer and Owner's Representative shall be removed at no additional cost to Owner and replaced at the Contractor's expense.

D. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.

1. Itemize equipment and material by specification Section number; include manufacturer and identifying model or catalog numbers.
2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
3. If a satisfactory replacement is not submitted within a two-week period, owner may notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to owner.
4. At the discretion of the Owner's representative, continued, uncorrected submittals may result in paying for the additional engineering review time.

E. Startup and Test Procedures:

1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.

2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.

3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.

4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

F. As-Built and Record Drawings:

1. Maintain a master set of as-built drawings that show changes and other deviations from the Drawings. The markups must be made as the changes are done.

2. At the conclusion of the project, these as-built drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner's Representative, and shall be complete.

3. Prior to final acceptance, deliver to the Owner's Representative the AutoCAD electronic files, the complete set of record drawings showing the as-built condition of the project, and the actual field set of as-built drawings. Also deliver one set of as-built drawings on CD-ROM or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).

4. Quantity: In accordance with the requirements of Division One and the General Conditions. Where not specified elsewhere, provide 3 hard copies plus one reproducible set.

G. Operating and Maintenance Manuals: As specified in Part 3 of this Section and in Division One, as applicable.

H. Overcurrent Protective Device Coordination Study: Provide preliminary and final study as specified in Section 26 05 73. Make adjustments to materials and submittals under other Sections of Division 26 as required and as recommended by the Overcurrent Protective Device Coordination studies.

1.6 SAFETY

A. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of Project Safety Manual (PSM).

1. The Contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.

2. The Contractor shall secure all electrical rooms, to limit access, prior to energizing any switchgear and shall control access during the project after energization.

3. The Contractor shall post and maintain warning and caution signage in areas where work is on going near energized equipment. The Contractor shall appropriately cover and protect all energized live parts when work is not being done in the equipment. This includes lunch and breaks.

4. The Contractor shall ensure that all conductors are properly capped off during installation, before and after being energized.

5. The Contractor shall strictly enforce OSHA lock out/tag out procedures. Initial infractions shall result in a warning; a second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

1.7 SHORING AND EQUIPMENT SUPPORTS

A. The Contractor shall provide all permanent and temporary shoring, anchoring, and bracing required to make all parts absolutely stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

B. The Contractor shall adequately support all freestanding panels, motor control centers, enclosures, and other equipment. This shall include bolting to the floor or solid structural steel to prevent tipping. Install free-standing electrical equipment on 4" thick concrete housekeeping pads that are provided by others. Under no condition shall equipment be fastened to non-rigid building steel (i.e., removable platform steel gratings, handrails, etc.).

C. The Contractor shall provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. At no time shall the Contractor mount or suspend equipment from other disciplines' supports.

1.8 TEMPORARY POWER REQUIREMENTS

A. Provide a power distribution system, in accordance with the NEC requirements, sufficient to accommodate construction operations requiring power, including power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15 and 20 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

B. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.

C. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate equipment grounding conductor.

D. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.

E. Provide NEC compliant temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load and be dedicated circuits. Temporary wiring shall be furnished with a grounding conductor throughout the entire length. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels and submit plan for approval by the owner.

F. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.

G. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to Uniform General Conditions and Supplementary General Conditions for substitution of materials and equipment.

B. The intent of the Drawings and/or Specifications is neither to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

E. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

F. All equipment installed on this project shall have local representation; local factory authorized service, and a local stock of repair parts.

G. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

H. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

I. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

J. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or

equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Materials shall be of a standard industrial quality if no specifications or specific model numbers are given.

B. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

C. All materials shall be new and unused.

D. Provide non-metallic material in corrosive areas or as otherwise specified.

E. All electrical equipment, conduit, and boxes mounted outside shall be supported using corrosion resistant (stainless steel or galvanized) products, e.g. Unistrut, hangers, rods, bolts, nuts, washer, etc…

F. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.

G. Products must conform to requirements of the National Electrical Code.

H. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Where no specifications or specific model numbers are given, provide materials of a standard industrial quality.

I. Space Limitations: Equipment selected must conform to the building features and must be coordinated with them. Electrical installation shall comply with the requirements of Article 110of the National Electric Code for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. If arrangement or equipment is different from construction drawings, scaled drawings (1/4" = 1'-0") of electrical and telecommunication rooms shall be submitted for review and approval by the Architect/Engineer and the Owner's Representative prior to installing equipment.

J. Factory Finish. Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

K. Physical Size of Equipment: Equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless the Contractor demonstrates by product data, shop drawings, and coordination drawings that ample space exists for proper installation, operation, and maintenance.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Install work in compliance with NEC.

B. Install material and equipment in accordance with manufacturers' instructions. Use calibrated torque wrenches and screwdrivers to tighten all terminals, lugs, and bus joints

C. Comply with startup procedures as defined by Construction Manager and Owner.

D. Arrange electrical work in a neat, well-organized manner. Do not block future connection points of electrical service. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.

E. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.

F. Make openings through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

G. Concrete Equipment Pads.

1. Refer to structural Drawings and specifications for design criteria.

2. Where not otherwise indicated, install 3-1/2 inch thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. For equipment mounted outdoors, provide concrete foundations a minimum of 5 1/2 inches above grade. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 4 inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.

3. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.

H. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

1. Equipment must be leveled and set plumb.

2. Sheet metal enclosures mounted against a wall shall be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers, or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment.

3. In sufficient time to be coordinated with work under other divisions, provide shop drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.

4. Provide adequate support for freestanding panels, switchboards, enclosures, and other equipment. This shall include bolting to the floor, concrete equipment pad, or solid structural steel to prevent tipping. Install free-standing electrical equipment on concrete equipment pads, except where equipment is noted and designed for mounting directly on the concrete floor slab. Under no condition shall equipment be fastened to non-rigid building steel such as removable platform steel gratings, handrails, etc.

5. Provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. Do not mount or suspend equipment from supports provided for equipment and systems by other Divisions, except where specifically noted or indicated on Drawings.

6. Refer to Section 26 05 29Securing and Support Methods, for additional requirements.

I. Sealing of Equipment. Seal openings into equipment to prevent entrance of animals, birds and insects, as well as to prevent ingress of moisture, dust, dirt, and similar contaminants.

J. Motors.

1. Motors are specified in Divisions 21, 22 and 23.
2. Electrical work includes the electrical connection of motors, except those which are wired as a part of equipment.
3. Refer to other applicable Divisions for wiring and connection of motors and equipment furnished by those Divisions.
4. The Contractor shall note that the electrical Drawings are based on the equipment scheduled and indicated on the Drawings. Should contractor initiated changes to the issued design result in mechanical equipment requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
5. Provide interconnecting wiring for the installation of the power required. Provide disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. Combination starters, individual starters, and other motor starting apparatus, not specifically scheduled or specified as provided by the equipment manufacturer under the scope of other Divisions shall be provided under the scope of Division 26.
6. Other Divisions will provide complete wiring diagrams indicating power wiring and interlock wiring for equipment under those Divisions. Diagrams shall be submitted to the Architect/Engineer for review upon request. Diagrams will be based on accepted equipment and be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams. They will be followed in detail. For additional clarification, refer to the other Divisions as applicable.

K. Concealed Work. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
2. Where exposure is necessary to the proper function.
3. Where size of materials and equipment preclude concealment. Obtain the written consent of the Owner's Representative and the Architect/Engineer to leave materials exposed in finished spaces of the building.

L. Application. Unless otherwise indicated or approved by A/E and Owner’s Representative, power will be utilized as follows:

1. 480 volts, three phase: motors 3/4 horsepower and larger.
2. 120 volts, single phase: motors 1/2 horsepower and smaller.
3. 277 volts, single phase: fan powered boxes.
4. 120 volts, single phase: incandescent lighting.
5. 277 volts, single phase: fluorescent and high-intensity-discharge lighting.
6. 120 volts, single phase: convenience outlets, dedicated equipment, lab-track terminal boxes without fans.
7. 208 volts, single and three phase: specialty outlets.
8. 480 volts, three phase: special power and equipment; verify for each unit of equipment.

M. Transformers. Use transformers where indicated or as otherwise required to change the service to the required utilization voltages.

N. Connections to Equipment - Other than Division 26. For equipment furnished under other Divisions, and for equipment furnished by the Owner, provide final electrical connections to such items of equipment. Obtain detailed shop drawings of equipment from the applicable Division or supplier indicating the exact number and location of rough-in points. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the work required.

1. Roughing-in: Terminate at proper points as indicated on detailed equipment shop drawings, or as directed. Use Drawings accompanying these specifications only for general routing of circuiting. Do not use Drawings accompanying these specifications for rough-in locations.

2. Final Connections: Where millwork, casework, and similar equipment includes service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on the casework or equipment, provide branch circuit connections to match electrical connection requirements of service fittings.

O. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are reasonably required for a complete system shall be provided, even if not specifically indicated on the Drawings or mentioned in the specifications. Offsets, transitions and changes in direction of conduit, cable trays, raceways and busways shall be made to maintain proper headroom and clearances. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.

P. Observation prior to cover-up or seal-in of walls and ceilings:

Perform the following in accordance with the applicable requirements of Division One and the General Conditions:

1. Prior to the installation of ceiling material, such as gypsum, plaster, or acoustical board, the Contractor shall notify the Owner's Representative so that arrangement can be made for observation or inspection of the above-ceiling area about to be "sealed" off from view. The Contractor shall provide advance notice in accordance with the applicable requirements of Division One and the General Conditions. Where not specified or directed elsewhere, provide not less than 10 working days' advance notice.

2. Above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. Electrical work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements, including power to luminaires, fans, and other powered items. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and other above ceiling special systems such as cable tray systems. The ceiling supports shall be in place so that access panel and luminaire locations are identifiable, and so that clearances and access provisions may be evaluated.

3. No ceiling materials may be installed until the resulting deficiency list from this inspection is completed and approved by the Owner's Representative.

Q. Finish. Coordinate with Division 9 to paint exposed conduit to match adjacent walls, unless otherwise directed.

1. 3.2 SERVICE CONTINUITY

R. Coordinate with Owner’s Representative to maintain continuity of electric service to all functioning portions of process or buildings during the hours of normal use. Phase construction work to accommodate Owner’s occupancy requirements.

S. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.

T. All service outages shall be requested in writing a minimum of two weeks prior to the date. Owner reserves the right to postpone shutdowns up to 24 hours prior to the shutdown at no additional cost. Outage requests shall include a schedule of the work to be performed and the time requirements.

U. The Contractor shall obtain all appropriate Owner permits for working in equipment.

3.3 HAZARDOUS LOCATIONS

A. Equipment, wiring, devices, and other components located within hazardous areas are to be of the appropriate type per NFPA requirements.

B. Ground exposed non-current carrying parts of entire electrical system in hazardous areas, in accordance with NEC and as instructed by Owner.

3.4 SLEEVES AND SEALS

A. General. Cut and patch walls, floors, etc., resulting from work in existing construction. Provide for the timely placing of sleeves for raceway and exposed cabling passing through walls, partitions, beams, floors and roof while same are under construction. If openings, sleeves, and recesses are not properly installed and cutting and patching become necessary, it shall be done at no expense to the Owner. Secure permission from the Owner's Representative before cutting or patching a constructed or existing wall. Where roofs or walls are fire rated, penetrations shall be completely sealed using UL-listed materials and procedures sufficient to preserve the fire rating. Comply with special requirements of local authorities.

B. Structure. Do not cut or core through structural beams, joists, load-bearing walls, grade beams, or similar load-bearing structure. Where limited space is available above the ceilings below concrete beams or other deep projections, notify the Owner's Representative in writing, including a proposed solution, and request a resolution. Approval shall be obtained from the Owner's Representative and the Architect/Engineer for each penetration.

C. Penetrations.

1. If this contract requires core drilling of floor or wall penetrations as indicated on Drawings, core drilling shall be in accordance with structural specifications. Floor penetrations shall include a sleeve that extends above the floor 2 inches, except where plugs and caps are specified or indicated flush with floor or foundation pad. Electrical penetrations shall be coordinated with structure during design, and shall be made in compliance with structural requirements specified in the structural Drawings and specifications. Field modifications are required to be reviewed and approved by structural engineer prior to installation.

2. Penetrations shall be sealed in accordance with the firestopping requirements of Division 7, . Coordinate with Division 7 to provide firestopping systems and materials that are compatible with the penetrations for systems and equipment furnished and installed under Division 26.

3. Provide sleeves for conduit penetrations of smoke, fire, and sound rated partitions. Install sleeve with a minimum of 1 inch diameter where penetrating the exterior drywall.

4. Provide proper sizing of sleeves or core-drilled holes to accommodate their through-penetrating items. In general, and unless noted otherwise, provide conduit sleeves two standard sizes larger than their through-penetrating items. Provide larger sleeves as required to allow passage of couplings for through-penetrating items.

D. Sealing and Firestopping.

1. Voids between sleeves or core-drilled holes and pipe passing through fire-rated assemblies shall be firestopped to meet the requirements of ASTM E 814, in accordance with Division 7 requirements for Firestopping.
2. Where the routing of cable tray passes through fire-rated walls, floors or other fire-rated boundaries, coordinate with Division 7 to provide removable firestopping system.
3. Furnish and install UL Systems Classified, intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250° F, for the sealing of holes or voids created to extend electrical systems through fire rated floors and walls, in order to prevent the spread of smoke, fire, toxic gas or water.
4. Fire barrier products shall be used to create through-penetration firestop systems as required. Firestop systems shall be listed in the Underwriter's Laboratories Building Materials Discovery, Through Penetration Firestop Systems (XHEZ).
5. Install firestop materials and systems according to their UL Systems Classifications, manufacturer instructions, manufacturer recommendations, and the requirements of applicable Division 7 specifications.

E. Conduit Sleeves. Conduit sleeve shall be two standard sizes larger than the size of conduit it serves, except where "Link Seal" casing seals are used in sleeves through walls below grade. Sleeves in floor shall extend a minimum of two inches above the finished floor. Conduit passing through concrete masonry walls above grade shall have 18-gauge galvanized steel sleeves. Sleeves set in concrete floor construction shall be at least 16-gauge galvanized steel except at conduit supports. Sleeves set in concrete floor construction supporting conduit risers shall be standard weight galvanized steel. Sleeves supporting conduit risers 3 inches and larger shall have three 6 inch long reinforcing rods welded at 120 degree spacing to the sleeve, and shall be installed embedded in the concrete or grouted to existing concrete. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve. Seal around penetrations through sleeving as indicated under firestopping as specified herein, and in compliance with the requirements of Division 7 specifications.

F. Penetrations Below Grade. Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be two inches wider in radius than the sleeve it encircles. The entire assembly shall be hot-dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with a "Link-Seal" or equivalent casing seal or equivalent product. Size conduit sleeve to accommodate the casing seal.

G. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and core drills, and at such locations acceptable to the Owner's Representative. Impact type equipment shall not be used except where specifically accepted by the Owner's Representative. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.

H. Restoration. Restore openings to "as new" condition under the appropriate specification Section for the materials involved, and match remaining surrounding materials and/or finishes.

I. Masonry. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent damage to the masonry caused by the cutting operation. Structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner's Representative.

J. Structure. No cutting, boring, or excavating which will weaken the structure shall be undertaken. Coordinate with structure for placement of conduit, sleeves, and the like through beams, joists,

slabs, mats, and other structural components and systems prior to forming of those structural components and systems.

K. Watertight. Where sleeves pass through roof or floors requiring waterproof membrane, lead flashing with a density of at least three pounds per square foot shall be built into the membrane a minimum of six inches to provide a watertight installation. Provide other watertight installation materials as detailed on the Drawings and as specified under Division 7 - Roofing.

L. Escutcheons. Unless otherwise directed by the A/E, provide heavy chrome-plated or nickel-plated plates on conduit passing through walls and ceilings in finished areas. Escutcheons shall be B&C No. 10, or as indicated, or by accepted substitution, chrome-plated steel plates with concealed hinges.

M. Roof Penetrations and Flashings. Furnish and install pipe, conduit and duct sleeves, and flashing compatible with the roofing installation for roof penetrations. Coordinate with Division 7.

3.5 CONSTRUCTION REVIEW

A. The Engineer or Owner's representative will review and observe installation work to insure compliance by the Contractor with requirements of the Contract Documents.

B. Review, observation, assistance, and actions by the Engineer or Owner’s representative shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.

C. The fact that the Engineer or Owner’s representative do not make early discovery of faulty or omitted work shall not bar the Engineer or Owner’s representative from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.

D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the Engineer or Owner’s representative for an increase in the Contract price, or for any payment on account of increased cost, damage, or loss.

3.6 WARRANTY

A. Provide warranties in accordance with the requirements of Uniform General and Supplementary Conditions (UGC).

3.7 CLEANING, ADJUSTING AND START-UP

A. Cleaning. Clean electrical equipment, components, and devices prior to installation of final finish or covers, prior to startup and testing, prior to final observation by Architect/Engineer and Owner's Representative, and as required under individual Sections of the Division 26 specifications.

B. Adjusting. Adjust equipment, devices, and systems as specified under individual Sections of these Specifications and in accordance with manufacturer's instructions for proper functioning during modes of operation, including emergency and shutdown conditions.

C. Factory Authorized Representative. Where specified for an individual item of electrical equipment, provide a factory authorized representative for adjustment, start-up, and testing of equipment, and instruction of Owner's operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

3.8 TESTING

A. Test Conditions. Use field startup and testing procedures submitted in accordance with this Section and accepted by the Owner's Representative and the Architect/Engineer. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.

B. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract completion date to permit adjustment and alterations within the number of days allotted for completion of the contract. Inform the Owner's Representative in advance of test dates in accordance with the applicable requirements of Division One and the General Conditions. Where not specified or directed otherwise, allow a minimum of at least 10 working days advance notice.

C. Retests. Conduct retests as directed by the Owner's Representative of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Delays resulting from retests do not relieve the Contractor of his responsibility under this contract.

D. Commissioning. Coordinate with commissioning agent, as applicable, for field testing and commissioning of electrical components and systems.

E. Test Reports. Submit copies of test reports to the Architect/Engineer in accordance with Division One requirements.

3.9 OPERATING AND MAINTENANCE MANUALS

A. General. The Contractor shall provide, in loose-leaf binders, complete operating and maintenance data of each manufactured item of equipment used in the electrical work at least four weeks before Architect/Engineer's final review and observation of the project. Descriptive data and printed installation, operating and maintenance instructions for each item of equipment will be included. A complete double index will be provided as follows.

1. Format and content. The Operating and Maintenance Manual will be submitted in quantities and format as specified under Division One for Submittals. Provide quadruplicate where quantity is not specified. Operating and Maintenance Manual shall include:

2. Descriptive data of each system and piece of equipment, including ratings, capacity, performance data, operating curves and characteristics, and wiring diagrams.

3. Full detailed spare parts list, including source of supply for each piece of equipment.

4. Printed instructions describing installation, operation, service, maintenance, and repair of each piece of equipment.

5. Typewritten test reports of tests made of materials, equipment and systems under this Division. Test reports will include the dates of the tests, name of person conducting and witnessing the tests, and record of conditions relative to the tests.

6. Copies of "Reviewed" shop drawings and submittals.

B. Print copies of the record Drawings. Refer to requirements this Section.

END OF SECTION

SECTION 26 01 00 – ELECTRICAL 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. Action Submittals: Written and graphic information and physical samples that require Engineer’s responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Division Section as "informational submittals."

C. 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.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of Division 26/28 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 Engineer’s 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 startup 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.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Engineer’s final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for delivery.
    i. Scheduled dates for installation.
    j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Engineer’s Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.

1. Engineer will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing and Project record drawings.

    a. Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    b. Contractor shall execute a data licensing agreement in the form of Halff Associates’ Standard form.

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 all submittal items required for each Specification Section within a Construction Division concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule. ***
    - **This submittal package shall be comprehensive document by Division and not piecemealed by specification section.**
3. Submit action submittals and informational submittals required by the same Specification Section concurrent.

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. For example, HVAC Equipment must be submitted and approved prior to approval of Electrical gear.

    a. Engineer 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, as follows. Time for review shall commence on Engineer'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 15 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 10 working days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals is indicated, allow 15 working days for initial review of each submittal.

D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
3. Include the following information for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Construction Manager, where applicable.
    e. Name of Contractor.
    f. Name of subcontractor.
    g. Name of supplier.
    h. Name of manufacturer.
    i. Submittal number or other unique identifier, including revision identifier.

        1) Submittal number shall use Specification Division Section or number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).

    j. Number and title of appropriate Specification.
    k. Drawing number and detail references, as appropriate.
    l. Location(s) where product is to be installed, as appropriate.

m. Other necessary identification.

4. Additional Paper Copies: Unless additional copies are required for final submittal, initial submittal may serve as final submittal.

   a. When paper copies are required, submit one copy of submittal.

5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will return without review submittals received from sources other than Contractor.
   a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:

      1) Project name.
      2) Date.
      3) Destination (To:).
      4) Source (From:).
      5) Name and address of Engineer.
      6) Name of Construction Manager, where applicable.
      7) Name of Contractor.
      8) Name of firm or entity that prepared submittal.
      9) Names of subcontractor, manufacturer, and supplier.
      10) Category and type of submittal.
      11) Submittal purpose and description.
      12) Specification Section number and title.
      13) Specification paragraph number or drawing designation and generic name for each of multiple items.
      14) Drawing number and detail references, as appropriate.
      15) Indication of full or partial submittal.
      16) Transmittal number, numbered consecutively.
      17) Submittal and transmittal distribution record.
      18) Remarks.
      19) Signature of transmitter.

E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

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. Alternately, submit package as a comprehensive .pdf document by Division with each Specification Section tabbed.
2. Name file with submittal number or other unique identifier, including revision identifier.

   a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-

061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).

3. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner**,** containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name of Construction Manager, where applicable.
    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.

F. Options: Identify options requiring selection by Engineer.

G. 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 Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

H. 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 Engineer’s action stamp.

I. 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.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Post electronic submittals as PDF electronic files directly to Project Web site or FTP site specifically established for Project.

    a. Engineer will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

1. Action Submittals: For submittal formats 11 x 17 and larger, submit two paper copies of each submittal unless otherwise indicated in addition to the electronically posted submittal. Engineer will return one copy of paper submittal.
2. Certificates and Certifications Submittals: Provide a 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 construction Division 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 (8-1/2 x 11 format only) in the following format:

   a. 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 sheets at least 11 x 17 but no larger than 30 by 42 inches.
3. Submit Shop Drawings in the following format:
   a. Two opaque (bond) copies of each submittal. Engineer will return one copy. Engineer will return one copy. Submit also one electronic file for record keeping.

4. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.

   a. Prepare Shop Drawings in the following format: Same digital data software program, version, and operating system as the original Drawings.
   b. Refer to Section 013100 "Project Management and Coordination" for requirements for coordination drawings.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these 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 for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. "Samples for Verification" Subparagraph below can be used with or without Samples for initial selection. Revise to suit Project.

E. 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.

F. 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.

G. 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.

H. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

I. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

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 Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file 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 following format: 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 Engineer.

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 ENGINEER'S ACTION

A. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it. Engineer 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 Engineer.

C. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

D. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION 26 01 00

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Hinged cover enclosures and cabinets

B. Contactors

C. Control relays

D. Push buttons, and selector switches

E. Terminal blocks and accessories

F. Penetration sealing systems (fire stops)

G. Electrical/control portion of HVAC work covered by Division 23 pertaining to basic electrical materials and methods shall follow the requirement set forth by this and all specifications.

1.2 APPLICABLE CODES AND STANDARDS

A. NFPA 70, National Electrical Code (latest adopted edition)

B. National Electrical Safety Code, (NFPA 70E)

C. Applicable publications of NEMA, ANSI, IEEE and IESNA

D. Underwriters Laboratories, Inc. Standards (UL)

E. Federal, city, state, and local codes and regulations having jurisdiction

F. OSHA recognized Nationally Recognized Testing Laboratories

G. OSHA requirements

H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

I. NEMA WD 1 – General-Purpose Wiring Devices

J. UL 98 - Enclosed Switches

1.3 INTENT

A. A. This Section is not, and shall not be interpreted to be a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.

B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.

C. All materials and equipment shall be of types and manufacturer specified wherever practical. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of equipment acceptable for use and shall in no way be construed to limit procurement from other manufacturer.

1.4 SUBMITTALS

A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, 260100, Submittals and Division 01 for submittal requirement.

B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit. Damaged materials shall be removed from project site.

B. In their factory-furnished coverings, store materials in a clean, dry indoor space, which provides protection against the weather.

PART 2 - PRODUCTS

2.1 ENCLOSURES AND CABINETS

A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 26 05 00-1. Exceptions shall be specifically designated on the Drawings.

Table 26 05 00-1
Enclosures

Location	Environment	Enclosure Type
Indoor Utility	Dry, subject to dust, falling dirt and dripping non-corrosive liquids	NEMA 12

Indoor	Clean, Dry	NEMA 1
Indoor	Wet, subject to hose-directed water	NEMA 4
Outdoor	Subject to falling rain, sleet, and external ice formation	NEMA 3R
Indoor or Outdoor	Subject to corrosion, windblown dust and rain, splashing water and hose-directed water	NEMA 4X

B. Enclosures shall have the following properties:

1. Hinged Cover Enclosures: NEMA 250.

a. Type 1: Steel.

b. Type 4: Steel with gasket door, rain tight.

c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).

d. Type 12: Steel with gasketed door, dust-tight.

C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.

D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.

E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14 gauge steel, white enamel finish.

F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

2.2 CONTACTORS

A. Acceptable Manufacturers

1. Square D Company, Eaton, General Electric

2. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.

C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.

D. Control Transformer: Provide when indicated on Drawings and size for the application. Minimum capacity shall be 100 VA. Provide primary and secondary fuse protection.

E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.

F. Size: NEMA ICS 2; size as indicated on Drawings.

G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.

H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.3 CONTROL RELAYS

1. Cutler-Hammer Type M-300

2. Square D Company

3. General Electric Type CR120A

4. Allen-Bradley

5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.

C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide as field convertible from ON delay to OFF delay and vice versa.

D. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.4 PUSH BUTTONS AND SELECTOR SWITCHES

A. Acceptable Manufacturers

1. Allen-Bradley

2. Square D

3. Cutler Hammer

4. Seimens

5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.

C. For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.

D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.

E. For corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.

F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 16195.

G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.5 TERMINAL BLOCKS AND ACCESSORIES

A. Signal And Control Terminals

1. Acceptable Manufacturers

a. Phoenix Contact

b. Buchanan

c. Weidmüller

d. Entrelec

e. Other manufacturers equal in design and function will be consid¬ered upon A/E approval following substitution procedure in 23 00 00 and Division 01 for substitution requirement.

2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24 inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.

B. Power Terminals

1. Acceptable Manufacturers

a. Buchanan

b. Ilsco

c. Square D Company

d. Burndy

e. Other manufacturers equal in design and function will be consid¬ered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

2. Power Terminals: Unit construction type, closed back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

2.6 PENETRATION SEALING SYSTEMS (FIRE STOPS)

A. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See the Division 7 Sections on Fire Stopping and Joint Sealants for sealing requirements and systems.

2.7 UL LISTING

A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose.

B. OSHA recognized National Testing Laboratories providing equivalent testing, labeling and listing services as UL will be considered for approval, where appropriate for the equipment, system or function.

PART 3 - EXECUTION

3.1 FABRICATION - CONTROL ENCLOSURES AND CABINETS

A. Shop assembles enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.2 INSTALLATION - ENCLOSURES AND CABINETS

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

B. Provide accessory feet for freestanding equipment enclosures.

C. Install trim plumb.

3.3 ERECTION OF EQUIPMENT

A. Manufacturer's Installation Instructions: Where furnished or called for by the manufacturer, equipment manufacturer's installation instructions shall be considered a part of this specification and fully complied with.

B. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.

C. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.

1. Safety Switches: 6 feet 0 inches (to top).

2. Pushbuttons: 4 feet 0 inches (to center).

3. Control Panels: 6 feet 0 inches (to top).

D. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, provisions shall be made to support conduits and flexible connections to control panels.

3.4 COORDINATION

A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified as needed by Engineer's field representative prior to installation.

B. Contractor is responsible for coordinating electrical work across all trades.

C. Information represented in electronic files is representative and diagrammatic in nature. Contractor is responsible for coordinating all trades and for maintaining up to date electronic files for coordination and record keeping purposes.

END OF SECTION 26 05 00

SECTION 26 05 19 CABLE, WIRE AND CONNECTORS, 600 VOLT

PART 1 GENERAL

1.01 WORK INCLUDED

A. Building wire:
   1. Power distribution circuitry.
   2. Control system circuitry.
   3. Lighting circuitry.
   4. Appliance and equipment circuitry.
   5. Motor-branch circuitry.
   6. Outdoors lighting and power.
   7. Other systems circuitry as designated.

B. Cable.

C. Wiring connections and terminations.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining 600 volt cable, wire and connectors shall follow the requirement set forth by this specification.

1.02 REFERENCES

A. NFPA 70 – National Electrical Code, latest edition.

B. NFTA – National Electrical Testing Agency, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. Where application of National Electrical Code, trade association standards or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

1.03 SUBMITTALS

A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures, and Division 01 for submittal requirements.

B. Submit manufacturer's literature and specification data sheets for each item of cable, wire connectors.

C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience.

1.04 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.

B. Store cable, wire and connectors in a clean, dry indoor space in their factory-furnished coverings, which provides protection against the weather.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Generally, cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.

B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.

C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.

D. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.

E. All cable specified for use in tray shall be multiconductor and shall have an outer jacket of flame-retardant, moisture and sunlight resistant polyvinyl chloride (PVC) and shall be UL and NEC approved type for tray installation.

F. All low voltage power and control cable installed in open cable tray above ceilings used for return air shall be plenum rated. Where tray cable is not available in size and type required, conductors shall be installed in conduit.

G. Use compression lugs for all wiring terminations, except on breakers or terminal strips in panel boards.

H. Provide factory applied color coded insulation unless otherwise approved per section 26 05 53 Electrical Identification, Part 2.1C.

2.02 BUILDING WIRE

A. WC 70/ICEA S-95-658-1999, Non-shielded 0-2kV Cables

B. Feeders and Branch Circuits-All sizes: 98% conductivity copper, soft-drawn, 600-volt insulation, THHN/THWN-2 Use XHHW-2 conductors where installed in conduit underground.
   1. No. 12 AWG and smaller: Provide solid conductor.
      No. 10 and larger: Provide stranded conductor.

2.03 REMOTE CONTROL AND SIGNAL CABLE

A. 600 Volt Insulation Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:
   1. Individual Conductors: 14 AWG, stranded copper, XHHW insulation. Rated 90°C dry, 75°C wet, color-coded per ICEA Method 1 plus one green equipment grounding conductor.
   2. Assembly: Bundle wrapped with cable tape and covered with an overall PVC jacket. Cable shall pass IEEE-1202 vertical tray ribbon-burner flame test (210,000 BTU) VW-1.

B. Instrumentation Cable:
   1. 300 Volt Instrumentation Cable, Multiple Pairs, Overall Shield, Type PLTC:

a. Individual Conductors: 18 AWG, stranded, tinned copper, flame retardant polyethylene or PVC insulated, rated 105°C, black and white numerically printed and coded pairs.
b. Assembly: Individual twisted pairs having a 100 percent coverage aluminum-polyester shield and 20 AWG stranded tinned copper drain wire. Conductor bundle shall be shielded with 100 percent coverage overall aluminum-polyester shield complete with 20 AWG drain wire. All group shields completely isolated from each other. Bundle wrapped with cable tape and covered with an overall flame retardant PVC jacket. Cable shall pass IEEE-383 vertical tray flame test (70,000 BTU) UL1581.

C. Life Safety Systems Cable:
1. All life safety system wiring shall be installed in dedicated conduit or raceway with adequate separation/shielding from all other systems.
2. Life safety systems wiring shall be as specified in the Section 28 31 00 - Fire Alarm and Smoke Detection Systems.

D. Security/Access Control/CCTV Cable:
1. All security/access control wiring shall be installed in dedicated conduits.
2. Security/access control wiring shall be rated and as specified below:

Circuit Type	No. of Conductors	Conductor Specifications	Cable Specifications
20 mA Current Loop	2	18-gauge, stranded copper	2 cables, 1 twisted pair each required
Card Reader Coaxial	--	18-gauge, solid copper, center conductor	Schlage Model No. SE9284PL or Anicom 5910PL
Contact Circuits	2	18-gauge, stranded copper	Nonshielded, twisted
CCTV Coaxial	--	--	Belden 89259 plenum rated, or approved equal

3. All security/access control power circuit wiring shall comply with paragraph 2.2. Building Wire of this Section.

E. Plenum Cable for Class 3 Remote Control and Signal Circuits: 98% conductivity copper conductor, 300-volt insulation, rated 60-degree C, UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.04 WIRING CONNECTIONS AND TERMINATIONS

A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. Select from only following types, classes, kinds and styles.
1. Type:
a. Solderless pressure connectors.
b. Crimp.
c. Threaded.
d. Insulated spring wire connectors with plastic caps for 10 AWG and smaller.
2. Class: Insulated.
3. Material: Copper (for CU to CU connection).
4. Style:
a. Insulated terminals. Use ring-terminal for control wiring. Use flange (fork) spade compression terminal for termination of stranded conductors at wiring devices, including ground connection.
b. Split bolt-parallel connector.
c. Pigtail connector.

d. Pre-insulated multi-tap connector.

PART 3 EXECUTION

3.01 INSPECTION

A. Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 GENERAL WIRING METHODS

A. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.

B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Do not install the conductors until raceway system is complete and properly cleaned.

C. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Types THWN-2 and THHN-2 in building interiors and other dry locations. Outdoors and underground in raceways, use Type XHHW-2. Conductors subject to abrasion, such as in lighting poles, shall be Type XHHW-2.

D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' in length (100' for 277 volt) no conductor smaller than a No. 10 wire shall be used. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions. Separate neutral conductors shall be provided for each phase of the same size for 120V/277V single-phase application for heavy electrical loads, computer loads, loads fed from isolated transformers, lab equipment, clinic equipment, dedicated circuits, unless noted otherwise on drawings. Voltage drop on feeders and branch circuits shall not exceed NEC requirement.

E. Include a separate neutral conductor with each phase conductor for all 120V and 277V circuits. Sharing of neutrals is not permitted. Provide a maximum number of 3 phase conductors in one conduit.

F. Remote 120 Volt control wires shall be no smaller than No. 14 conductors. Departures from the sizes so determined shall be made only in those cases in which the National Electrical Code requires the use of larger conductors. The sizes as determined from these tables shall be regarded as the acceptable minimum under all other circumstances. In no case, however, shall there be a voltage drop greater than that specified in any feeder or branch circuit. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown. Under no circumstances, however, shall the Contractor use any conductors sized in a manner which does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized Representative. Low voltage cables less than 120Volts and/ or lighting control wiring within plenum space shall be supported by J-hooks. Control wires 120Volts and above shall be run in separate conduits.

G. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.

H. Splice branch circuits only in accessible junction or outlet boxes. Control cable shall never be spliced except the final connection to field devices. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings. No WEGO type splicing connectors will be allowed.

I. Wiring Within an Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wire-ways when they are provided. Where wireways are not provided the Contractor shall neatly tag, bundle wires and secure to sub-panel at a minimum of every three inches with T&B Type TC5355 heavy duty mounting bases.

J. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

3.03 WIRING INSTALLATION IN RACEWAYS

A. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Pull conductors together where more than one is being installed in a raceway.

C. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

D. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.

E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

F. Place an equal number of conductors for each phase of a circuit in same raceway.
1. Contractor can combine circuits in a common conduit as long as derating of the conductors' ampacity and other NEC factors accounted for. The dedicated neutral conductor must be included as a current carrying conductor for all dedicated single phase circuits.

G. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.

H. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

3.04 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage during construction. Do not install cable before the completion of raceway system.

B. Cable above ceilings shall be in conduit or raceways. Cables, conduits and raceways shall not be laid on ceiling tiles or strapped to ceiling wire.

C. Use suitable cable fittings and connectors.

D. It shall be the Contractor's responsibility to accurately measure all cable runs before the cable is cut. The Contractor shall furnish all tools and equipment, have sufficient properly trained personnel and shall exercise necessary care to ensure that the cable is not

damaged during installation. Cable found to be damaged before installation shall not be installed. Cable damage during installation shall be removed and replaced. Repairs to cables can only be done with written permission from the Owner's Representative and only under special circumstances.

E. Care shall be exercised with cables entering or leaving cable trays that all cable bend radii shall not be less than the recommended minimum and that cables are not left to rest unprotected on any sharp edge or corner.

F. PVC jacketed cable shall not be installed or worked in any way at temperatures below 32°F, unless cable has been previously stored in a heated area 48 hours prior to being pulled and transported to a heated pulling area.

G. Each cable entering an enclosure shall have its conductors bundled together and identified with the cable number. All groups of conductors within an enclosure shall be shaped and formed to provide a neat appearance to facilitate future additions or rework. All control conductors shall be numbered and shall be labeled at each termination with this number, using markers designed for the application.

H. Multi-Conductor Cable Installation: Power and 120V control cable shall be installed in the same tray. When cables leave trays, they shall be protected between the trays and the cable terminal points by drawing them through conduits. Do not route 600V cables (power cable and 120V control cable) in the same conduit or cable tray as low voltage cables (less than 50V, communications, security systems, or control conductors). Do not route security systems, or control cables through communications rooms. Fire alarm cable shall be routed in a separate conduit only.

I. Instrument Cable: Instrument cable shall, when conduit installation is required be installed in rigid steel conduit. They shall not be spliced at any point. The shields and drain wires of shielded signal cables shall be grounded only at one point as indicated on the Drawings.

3.05 WIRING CONNECTIONS AND TERMINATIONS

A. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

B. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only. Control circuit conductors shall terminate at terminal blocks only. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast.

C. Use splice, tap and termination connectors, which are compatible with the conductor material.

D. Thoroughly clean wires before installing lugs and connectors.

E. Terminate spare conductors with electrical tape and label as spare.

F. Power and Lighting Circuits: Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits. No WEGO type splicing connectors will be allowed.

G. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

H. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.

I. Identify conductors per Section 26 05 53 - Electrical Identification.

3.06 FIELD QUALITY CONTROL

A. Torque test conductor connections and terminations to manufacturer's recommended values.

B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

D. Conductors may be run in parallel on sizes 1/0 to 500 MCM inclusive provided all paralleled conductors are the same size, length, and type of insulation. Except as otherwise shown on drawings, no more than three conductors may be run in parallel, and they shall be so arranged and terminated as to insure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of the Owner's Representative must be obtained before installation is made.

3.07 TESTING AND ACCEPTANCE

A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's Representative the satisfactory installation and proper performance of all circuits.

B. Test feeder conductors clear of faults. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems. Test results below 50 megohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductor.

C. At the completion of this project, the Contractor shall provide for the Owner 3 complete and finally corrected sets of working drawings. These sets of working drawings shall be new, unused and in good condition, and shall include the nature, destination, path, size and type of wire and all other characteristics for complete identification of each and every conduit and circuit.

END OF SECTION 26 5 19

SECTION 26 05 26 – GROUNDING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Power system grounding.

B. Electrical equipment and raceway grounding and bonding.

1.02 RELATED WORK

A. Section 26 41 00 - Lightning Protection. Systems

B. Division 27, Communications.

C. Division 28, Electronic Safety and Security.

1.03 REFERENCES

A. NFPA 70 – National Electrical Code

B. ANSI/UL 467 – Electrical Grounding and Bonding Equipment

C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and Earth Surface Potential of a ground System

E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

F. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

G. NFPA No. 780 - Lightning Protection Code.

H. UL 96A - Master Labeled Lightning Protection System, Installation Requirements.

I. ANSI/NEMA GR 1-2007 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.

1.04 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.

B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.

C. Provide communications system grounding conductor connected to separate electrode (ground bus) that is installed in each IT room.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.

E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

F. Supplementary Grounding Electrode: Use driven ground rod on exterior of building. in main service equipment area. Install ground rod in suitable recessed well; fill with gravel after connection is made. Use effectively grounded metal frame of the building.

G. Use minimum 6 AWG copper conductors for communications service grounding conductor. Leave 10 feet slack conductor at termination board. Coordinate with Div. 27.

1.05 SUBMITTALS

A. Product Data. Submit product data sheets, including complete descriptive information on materials and installation methods.

B. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, 260100, Submittals, and Division 01 for submittal requirements

C. Shop Drawings.

1. Provide detailed plans prepared to 1/8-inch scale with 1/8-inch text which indicate the work to be performed. Details of component mounting and connections shall be included on separate detail drawings. Manufacturer's catalog numbers and generic identification shall be indicated for components shown on the Drawings.

2. Shop drawings shall include locations of conductors, roof penetrations, floor penetrations, etc., Contractor shall coordinate locations of conductors in walls and penetrations with the appropriate trades. Failure to coordinate these requirements shall not relieve this Contractor from properly completing this work. The Contractor shall employ the proper trades to provide the chases in walls and roof and floor penetrations required to install the conductors if not coordinated before the floors, walls and roof are installed.

D. Coordinated Submittal.

1. Submit product data and shop drawings for grounding system and lightning protection system at the same time and as one package. Indicate common components and interconnections between grounding and lightning protection systems. Refer to Section 26 41 00 for Lightning Protection system.

2. Coordinate submittal for grounding system with electrical service to building and with electrical service equipment.

3. Coordinate submittal for grounding system with telecommunications grounding system, as indicated on telecommunications Drawings. Refer to Division 27 telecommunications systems grounding system and grounding requirements.

E. As-Built Record Drawings. The Contractor shall maintain a master set of As Built record drawings that shows changes and deviations from the Drawings, in accordance with Division One

requirements and Section 26 00 00. Deliver As-Built record drawings to Owner upon Owner acceptance of project. Deliver one set of As-Built record drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in the editions of AutoCAD (.dwg) and Adobe Acrobat (.pdf) acceptable to the Owner.

PART 2 - PRODUCTS

2.01 GROUND RODS

A. Materials. Provide ¾-inch by 10-foot long, copper-clad, steel grounding electrodes. Supply a rod to which the copper cladding is permanently and inseparably bonded to a high strength steel core.

B. Listing. UL 467.

2.02 CONNECTIONS

A. Materials. Unless otherwise noted, provide exothermic welded type grounding connections for bonds and connections made below grade, embedded in structure, or otherwise concealed. Unless noted otherwise, for above grade connections not embedded in structure or otherwise concealed, provide mechanical bolted-type connections utilizing high-conductive copper alloy or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.

B. Listing. UL 467.

2.03 CONDUCTORS

A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity > 98 percent International Annealed Copper Standard (IACS) conductivity.

1. Use solid conductor for No. 12 and smaller.
2. Use stranded conductor for No. 10 AWG and larger.
3. Use stranded conductor for applications subject to continuous vibration, such as engine generators and terminations at motors.
4. Use stranded, tinned, annealed copper cable for #2 AWG or larger installed inside the building or structure.

B. Insulation. Where insulated grounding conductors are specified or required, provide green-colored 600-volt rated insulation, type XHHW, THWN, or RHW. Insulation type shall be compatible with associated power and lighting system conductors.

C. Location and Application.

1. Inside building or structure. Provide insulated copper grounding conductors, except where bare copper grounding conductors are indicated on Drawings or specified in this or other Sections.
2. Outside building or structure. Use bare tinned copper grounding conductors, including below-grade building grounding ring (counterpoise).
3. Bonding jumpers. Use bare copper conductor.

D. Listing. UL 83.

2.04 GROUND BUS

A. Where a field-provided ground bus-bar is required or indicated, provide bus-bar drilled and tapped with double-lug terminations for the quantity of ground connections indicated on the Drawings plus 25% spare capacity, wall-mounted on insulated supports. Use round-edge copper bar with > 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus-bar for not less than 25 percent of the aggregated cross-sectional area of the related feeders. A minimum cross-sectional size of 1/4 inch by 2 inches is required. Where a ground bus-bar of larger dimensions is indicated on the plans or specifications provide the bus-bar with the larger dimensions.

2.05 CHEMICAL GROUND TEST WELL/ROD

A. General

1. Self-contained Grounding System(s) using electrolytic action to enhance the grounding performance shall be provided where specifically indicated on the drawings.
2. Ground rod system shall be U.L. listed and manufactured for ten years or more.
3. Ground rod system shall be 100% self-activating, sealed and maintenance free. No additions of chemical or water solutions required.

2.06 MANUFACTURER

A. Copperweld.

B. Cadweld.

C. Burndy.

D. Harger.

E. Lyncole

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code and the National Electrical Contractors Association's "Standard of Installation".

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.

C. In feeder and branch circuits, provide a separate, insulated equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.

D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

E. Install fusion welded ground connectors where they are concealed or inaccessible.

F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.

G. No strap grounding clamps shall be used; connections requiring bolting shall be made up with monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

H. Install liquid tight flexible metal conduit with grounding bushings.

I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors. .

J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.

K. Connect grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection points below finished grade. Below grade connection shall be exothermic-welded type connectors as manufactured by Cadweld, Thermoweld. In manhole, install ground rods with 4 to 6 inches above the floor with connections of grounding conductors fully visible and accessible.

L. Provide grounding and bonding at Utility Company's metering equipment and pad-mounted transformer in accordance with Utility Company's requirements.

3.02 SYSTEM DESCRIPTION

A. Ground the electrical service neutral at service entrance equipment. Provide a main bonding jumper between the neutral and ground bus of the service entrance equipment where permitted per NEC. Provide a separate grounding electrode conductor in conduit with grounding bushings on both conduit ends from the switchgear to the master ground bus-bar (MGBB) at the main electrical room. Bond MGBB to cold water metallic service pipe in contact with at least 10 feet of earth, and connect to opposite points of the building grounding ring (i.e. counterpoise) system by two main grounding conductors.

B. Provide ground bus-bar, wall-mounted on insulated supports at 4’-0” AFF in electrical rooms, and radially connected to a master ground bus-bar in the main electrical room.

C. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.

D. Provide communications system-grounding conductor at point of service entrance and connect to separate grounding electrode. Bond together the communications system grounding electrode and the electrical service-grounding electrode. Separate grounding systems without interconnecting bonds or jumpers are prohibited.

E. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.03 SYSTEM GROUND

A. System Neutral. Where a system neutral is used, ground the system neutral as required by NEC Article 250 and as indicated on Drawings. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Size. Size the system grounding electrode conductors as indicated on plans.

C. Install grounding electrodes around exterior perimeter of building, a minimum of 3 feet outside the foundation of the building or facility. Space grounding electrodes at a distance between electrodes of at least twice their driven depth. Bond ground rods together with the building ground ring (counterpoise). Install grounding electrode conductor in undisturbed earth, a minimum of 2 feet below excavated depth of building structural mat, crawlspace, or sub-grade.

D. Depth: Bury grounding electrode conductors below grade to comply with NEC 250. Minimum depth 30 inches unless noted otherwise.

E. Provide grounding electrode conductor pigtails at each ground rod for connection to building structural steel. Place PVC sleeves through foundation at column locations. Provide minimum 12 feet of excess pigtail above the building foundation or structural mat, prior to placement of concrete. Coil pigtail conductors and support above finished level of mat or foundation during concrete pour to prevent excess pigtail from being embedded or cemented in concrete.

F. Provide main grounding electrode conductor pigtails at two locations on opposite sides of building for connection to power system neutral. Size main grounding electrode conductors as indicated on Drawings, minimum 4/0 AWG green-insulated copper conductor with Class-B stranding where not otherwise indicated. Provide larger conductors where indicated on Drawings. Place PVC sleeves through foundation and structure. Provide a minimum of 12 feet of excess pigtail above the building foundation or structural mat, as finally installed. Coil and support main grounding electrode conductor pigtails above finished level of mat or foundation during concrete pour to prevent excess conductor from being embedded or cemented in concrete. Connect grounding electrode conductors to main ground bus-bar at main electrical room. Connect power system neutral to main ground bus-bar at main electrical room. Provide test well for main grounding electrode conductor at each connection to ground rod, with reversible compression-type clamp.

G. Separately Derived Systems. Ground neutrals of separately derived systems such as generators and transformers in accordance with NEC 250.30 and as indicated on Drawings.

1. For each separately derived system, ground the neutral to system ground via the nearest ground busbar specifically provided for the purpose of grounding power distribution systems. Use unspliced grounding conductor from the neutral of the separately derived system to the ground busbar.

2. Grounding conductors shall be as short and straight as possible, protected from mechanical damage, without splice or joint except as permitted by NEC 250.

3. Transformers: Bond the center point (neutral or X0 terminal) of each wye-connected transformer to system ground at one point only. This point shall be ahead of the first overcurrent protective device (OCPD) connected to the secondary winding of the transformer. Refer to the applicable transformer specification for additional requirements.

3.04 SUPPLEMENTAL GROUND

A. Supplementary Grounding Electrode: Where indicated on Drawings, provide supplementary grounding electrodes (ground rods) and bond to equipment grounding conductors per NEC-250. Where larger bonding jumpers and/or conductors are indicated on Drawings, provide the size shown.

3.05 EQUIPMENT GROUND

A. Electrical Rooms: Provide a ground bus in electrical rooms, and at other locations indicated on Drawings.

1. Mount busbar 8 feet above finished floor and a minimum of 1 inch from wall.
2. Connect busbar by grounding conductor to the main ground busbar at the main electrical room. Size grounding conductor as shown on Drawings. Where size is not indicated, use grounding conductor with cross-sectional area equivalent to the ground busbar.
3. Connect noncurrent-carrying metallic parts of electrical equipment and enclosures in the room, to the ground bus.
4. Bond grounding conductors to the bus as further indicated on Drawings.

3.06 RACEWAY SYSTEMS AND EQUIPMENT ENCLOSURES.

1. Bond cabinets, cable trays, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, switchboards, panelboards, transformer enclosures, other electrical equipment and metallic enclosures. Bond equipment and enclosures to the continuous-grounded, metallic raceway system in addition to other specific grounding shown. Ground each outlet by the use of an approved grounding clip attached to the outlet box in such a position to be readily inspected upon removal of the cover plate, or by the use of an approved grounding yoke type receptacle.
2. Provide bonding jumpers and grounding conductors throughout the raceway system to ensure electrical continuity of the grounding system and the raceway.
3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus. Connect the bushing to the ground bus in the equipment enclosure.
4. Provide a green insulated equipment grounding conductor for each feeder and branch circuit. Terminate each end of grounding conductor on a grounding lug, bus, or bushing.
5. Provide a flexible bonding jumper for isolated metallic piping and ductwork and around expansion fittings and joints.
6. Provide internal grounding conductor on all liquid tight flexible metallic conduit (Sealtite).

B. Size. Where grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC Table 250.122. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250.122.

C. Taps, Splices and Connections: Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.

D. Manholes: Unless indicated otherwise on Drawings, provide a No. 1/0 AWG bare stranded copper ground bus in manholes. Mount bus 12 inches above floor using one-hole pipe straps 3'-0" on center. Connect bus to ground rod with a No. 1/0 AWG conductor. Bond metallic components and electrical grounding conductors to the bus using lugs or clamps.

E. Underground Duct Bank: Provide bare copper grounding conductor embedded in concrete of underground duct bank for communications, utility and power systems. Bond conductor to ground lug or ground bus at each end of duct bank and within manholes.

3.07 LIGHTNING PROTECTION SYSTEM

A. Bond together lightning protection system ground rods to building ground ring (i.e. counterpoise). Provide bonding conductors for lightning protection ground rods separate from power system grounding electrode conductors.

B. Bond together the lightning protection system ground rods and the power system grounding electrodes (i.e., ground rods) by connecting ground rods to the building ground ring (i.e. counterpoise). Make bonds at ground rods.

C. Refer to Section 26 41 00, Lightning Protection System.

3.08 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Testing: Test the completed grounding system by fall-of-potential method. Measure ground resistance from system grounding electrode main conductors to convenient ground reference point using suitable ground testing equipment.

C. Prepare test procedures and test forms to be used for field testing of completed grounding system. Procedures and forms shall include documentation of test equipment proposed for use in field testing of completed grounding system.

D. Resistance shall not exceed 5 ohm.

E. Testing points shall include measurement of ground resistance from system neutral at electrical service entrance to convenient ground reference point using suitable ground testing equipment.

F. Where measured resistance to ground exceeds 5 ohm, add additional ground rods to grounding system to achieve system resistance to ground of 5 ohm or less, and document measured resistance to ground after ground rods are added. Repeat as required to achieve resistance to ground of 1 ohm or less, at no additional cost to Owner.

G. Test isolated power systems per NFPA 99.

H. Documentation: Submit report of field testing of completed grounding system to Architect/Engineer and to Owner's Representative.

3.09 CONFLICTS

A. In the event a conflict exists between this specification and the referenced standards, most restrictive is to be followed. Identify any necessary variances required to be made in order to obtain a UL Master label for the lightning protection system.

END OF SECTION

SECTION 26 05 29 – SECURING AND SUPPORTING METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Raceway, cable tray, and equipment supports

B. Fastening hardware

C. Coordinate location of concrete equipment pads

1.02 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry. Support systems shall be sized adequately to support an additional 25% for future loads

1.03 COORDINATION

A. Coordinate with other trades where conduit and cable tray supports are in the same location as piping, ductwork, and work of other trades and where supports are furnished and installed under other Divisions. Supporting from the work or supports of other Contractors shall not be allowed except by express, written permission of the Owner.

1.04 SUBMITTALS

A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, 260100 Submittals, and Division 01 for submittal requirements.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Sleeves:

1. Furnish sleeves for all wall and floor penetrations and comply with fire rating requirements. Refer to Specification Section 260000 and 260544.

B. Support Channel:

1. All non-corrosive locations: Hot-dip galvanized steel.

2. Corrosive locations: Nonmetallic fiberglass.

C. Hardware:

1. All non-corrosive locations: Hot-dip galvanized steel.

2. Corrosive locations: Stainless steel threaded rod, attachments and fasteners shall be used with fiberglass supports.

D. Threaded Rod: used for rack support from structure above; 3/8-inch minimum diameter.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, or beam clamps. Do not use spring steel clips and clamps. Provide necessary calculations to select proper support materials for electrical equipment, raceway, and cable tray supports. Provide cable tray supports for cable tray filled to 125 percent capacity per NEC.

B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installation of supporting devices. Install supports with spacing in compliance with NEC requirements.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; or concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

E. Do not use powder actuated anchors without written permission from the Engineer.

F. Do not drill structural steel members without written permission from the Structural Engineer.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.

I. Install surface mounted cabinets and panelboards with a minimum of four anchors. Provide strut channel supports to stand cabinet 1-5/8 inches off wall. Utilize "Post Bases" where support channel is attached to structural floor.

J. Provide extra care in supporting PVC conduit to protect it from potential damage.

K. Use fiberglass for nonmetallic raceway systems supports in areas subject to corrosives.

L. All supports in contact with floor using stanchion type support shall be solidly bolted to the permanent structural floor.

M. Conduit supports shall have at a minimum, the bottom support member constructed of double strut. This horizontal member shall be double-nutted, and the supporting all-thread rod shall be trimmed to one inch below lowest nut.

N. Conduit entering/exiting cable tray shall be attached to the tray rail by means of support channel bolted to the rail and standard manufacturer's accessories. Conduit shall only enter/exit tray horizontally supported within three feet of the tray, and extended into the tray two inches. Conduit shall be terminated with a grounding bushing, and bonded to the tray ground wire. (The attachment to the tray shall not be considered a support.)

O. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

P. Install freestanding electrical equipment on 4-inch concrete pads. Pad shall be a minimum four inches larger than equipment. No crevices shall be left around the pads. Equipment includes but not limited to the following:

1. Floor mounted VFDs
2. Floor mounted transformers

3. Switchboards

3.02 TOUCH-UP

A. Touch-up all scratches on securing and supporting system, and paint the ends of channel after cutting with an approved zinc chromate or 90 percent zinc paint.

END OF SECTION

SECTION 26 05 33 – RACEWAYS, CONDUITS AND BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Raceways:

1. Surface metal raceways.
2. Multi-outlet assemblies.
3. Wireways.
4. Indoor service poles.

B. Conduit:

1. Rigid metal conduit and fittings. (RGS)
2. Intermediate metal conduit and fittings. (IMC)
3. Electrical metallic tubing and fittings. (EMT)
4. Flexible metal conduit and fittings.
5. Liquid-tight flexible metal conduit and fittings.
6. Non-metallic conduit and fittings. (underground use only)
7. PVC coated rigid steel conduit.

C. Boxes:

1. Wall and ceiling outlet boxes.
2. Pull and junction boxes.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining raceway, conduit and boxes shall follow the requirement set forth by this specification.

1.2 REFERENCES

A. NFPA 70 – National Electrical Code

B. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated

C. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated

D. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies

E. EMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing

F. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

H. ANSI/NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

I. ANSI/UL 1 – Flexible Metal Conduit

J. ANSI/UL 5 – Surface Metal Raceways and Fittings

K. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit

L. ANSI/UL 467 – Electrical Grounding and Bonding Equipment

M. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit (underground use only)

N. ANSI/UL 797 – Electrical Metal Tubing

O. ANSI/UL 870 – Wireways, Auxiliary Gutters and Fittings

P. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated galvanized Rigid Steel Conduit and Intermediate Metal Conduit

Q. UL 6 – Rigid Metal Conduit

R. ANSI/UL 5C – Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits

1.3 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Section 260100 Submittal Procedures.

B. Provide product data cutsheets and catalog information consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.

C. 2D Shop drawings indicating:

1. 2D Scaled floorplan drawings indicating routing, quantity, size and bottom of conduit/conduit support and pull boxes.

D. Sealing/fire stopping materials and details.

E. Surface Mounted Raceways

1. Product data

2. Scaled shop drawings indicating:

a. Wiring and connectivity of devices in raceway system

b. Wire fill of prewired or maximum wire fill of system wired in field.

c. Rough in requirements including quantity and locations of field connections

d. Manufacturer installation details and requirements

1.4 STORAGE AND HANDLING

A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.

B. Store materials in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 SURFACE METAL RACEWAY

A. Surface metal raceway shall be factory pre-assembled galvanized steel complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings, to exact length to match the length of the cabinets, casework, utility chases, and shelving as indicated on laboratory and furniture shop drawings, and work bench details, as applicable.

B. Size shall be as shown on the Drawings. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway Sections. Refer to shop drawings, architectural plans, elevations, and details.

C. Finish shall be ANSI-61 gray enamel .

D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.

E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system per drawing as applicable. Provide divider with fittings that maintain the separation of the raceway wiring compartments.

F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates.

G. Provide receptacles for the respective power systems as indicated on the drawings. Refer to Section 26 27 26 Wiring Devices for device specifications.

2.2 MULTI-OUTLET ASSEMBLY

A. Multi-outlet assembly shall be two-piece sheet metal channel with fitted, removable cover suitable for use as a multi-outlet assembly.

B. Size shall be as indicated on the Drawings.

C. Provide receptacles mounted as shown on Drawings.

D. Finish shall be ANSI-61 gray enamel.

E. Provide couplings, elbows, outlet and device boxes, and connectors designed for use with multi-outlet system.

2.3 WIREWAYS

A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.

B. Size shall be as indicated on Drawings.

C. Cover shall be hinged or screw applied as indicated on Drawings. Rain tight wireways shall be provided with full gasketing.

D. Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.

E. Provide all sheet metal parts with a rust inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

2.4 CONDUIT AND FITTINGS

A. Conduit and fittings for all electrical systems on this project shall include the following:

1. Service entrance
2. Electrical power and lighting feeders
3. Electrical power and lighting circuits
4. Telephone systems
5. Control systems (other than HVAC)
6. Fire alarm and signaling systems
7. CCTV rough-in system
8. Clock and bell system
9. Computer system rough-in
10. Sound system rough-in
11. Building Management System
12. Other electrical systems

B. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.

C. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by N.E.C. Article 250. Grounding bushings shall have insulated throats.

D. Rigid and intermediate metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type. Expansion fittings shall be OZ Type DX or equivalent.

E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression type. Expansion fittings shall be OZ Type TX or equivalent.

F. Flexible metal conduit and fittings shall be zinc-coated steel.

G. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC). It shall be furnished with a sealing O-ring where entering an enclosure subject to moisture. Where O-Rings are used, ground type bushings shall be used in the box or enclosure.

H. Nonmetallic conduit and fittings shall be suitable for temperature rating of conductor but not less than 90°C. Nonmetallic conduit and fittings shall be molded of high impact PVC compound having noncombustible, nonmagnetic, non-corrosive and chemical resistant properties and shall be of the same manufacturer. Where located outdoors and above ground, the conduit and fittings shall be UV resistant. Solvent cement shall be of the same manufacturer as the conduit and shall be of the brush-on type. Spray solvents are prohibited. PVC coated metallic fittings shall not be permitted for PVC conduit connections.

I. Crimp or set-screw type fittings are not acceptable.

J. Minimum conduit size shall be 3/4 inch, except 1/2 inch flexible metallic conduit may be used as fixture whips.

K. PVC coated rigid steel conduit shall be externally coated with a 40 mil PVC coating and internal phenolic coating over a galvanized surface.

L. Rigid and IMC sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

M. Die Cast fittings will not be allowed.

2.5 WALL AND CEILING OUTLET BOXES

A. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

1. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

2. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC, and not less than 1 ½ inch deep unless shallower boxes are required by structural conditions and are approved by the A/E.

B. Provide deep type cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and fasteners. Provide PVC type outlet boxes only in corrosive areas rated as NEMA 13X.

C. Outlet boxes in poured concrete shall be plenum type without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

D. Provide 4-inch octagonal ceiling outlet boxes.

2.6 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal conforming to ANSI/NEMA OS 1 with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.

C. Boxes shall be sized in accordance with NEC.

D. Provide cast-in-place, pre-cast concrete or die-molded fiberglass handholes/pull boxes as per design for underground installations. Cast-in-place and pre-cast boxes shall be provided with reinforcing bars with material compressive strength no less than 11,000 psi, and shall be approved by Owner/Structural Engineer.

2.7 CABLE TRAY AND FITTINGS

A. Ladder type cable trays

1. Tray: NEMA VE 1, Class 12C or as indicated on the drawings.
2. Material and Finish of Tray, Fittings, and Accessories: 6063-T6 aluminum extrusion or hot-dip galvanized after fabrication steel (ASTM A123) as indicated on Drawings.
3. Inside width: 12 inches minimum or as indicated on Drawings.
4. Inside depth: 4 inches minimum or as indicated on Drawings
5. Straight Section rung spacing: 12 inches on center.
6. Inside radii of fittings: as indicated on Drawings
7. Accessories and Fittings: Manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
8. Provide covers on tray where exiting the top of control cabinets, communication/data cabinets, distribution panelboards and switchboards which covers vertical Sections of tray and 90 degree bend.

B. Perforated bottom cable trays

1. Tray: NEMA VE 1, Class 12C.
2. Material and Finish of Tray, Fittings, and Accessories: 6063-T6 aluminum extrusion or hot-dip galvanized steel (ASTM A123).
3. Inside Width: 12 inches minimum or as indicated on Drawings.
4. Inside depth: 4 inches or as indicated on Drawings.
5. Inside radii of fittings: 12 inches.
6. Accessories and Fittings: Manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
7. Utilization: Data cables, control cables, telephone cables, fiber optics. Do not use for vertical sections. Vertical cables shall be installed vertical floor mounted racks.
8. Covers: Ventilated covers where indicated on the drawings.

C. Fiberglass cable trays

1. Tray: NEMA FG1
2. Material and finish of tray, fittings, and accessories: Glass fiber reinforced polyester.
3. Inside width: 12 inches minimum or as indicated on Drawings.
4. Inside depth: 4 inches minimum or as indicated on Drawings
5. Inside Radii of Fittings: 12 inches or as indicated on Drawings.

6. Accessories and Fittings: Manufacturer's standard clamps hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, and connectors.

7. Covers: Solid covers where indicated on the drawings.

D. Warning signs for cable trays

1. 1/2-inch high black letters on yellow plastic with the following wording:

2. WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 - EXECUTION

3.1 INSTALLATION - CONDUIT

A. Install products as indicated, in accordance with the applicable requirements of NEC, NEMA and the National Electrical Contractors Association's "Standard of Installation".

B. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported from racks supported on the floor.

C. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms, electrical rooms and exposed locations where there is a high potential subject to physical damage; exposed outdoor locations; wet or damp locations; or any location as per design drawing. The following exceptions permitted:

1. EMT

a. In sizes up to and including 2 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.

b. Where used for feeder circuits, lighting branch circuits, equipment branch circuits, receptacle branch circuits and motor branch circuits EMT shall also contain an NEC grounding conductor.

c. All conduits shall be concealed in walls or ceilings unless otherwise noted.

2. Rigid Non-Metallic

a. PVC shall only be used where shown on the drawings.

b. Install PVC schedule 40 conduit where direct buried in earth.

c. Install PVC schedule 80 , under areas of vehicular traffic.

d. Concrete encase where shown on drawings.

3. Liquid-tight

a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Maximum length shall be 6 feet, minimum of 2 feet.

b. Not permitted for use in plenum spaces unless UL listed for plenum use.

4. Flexible Metal Conduit

a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be 6 feet minimum of 3 feet; minimum size shall be 3/4; and minimum size shall be ½ inch for lay-in light fixture whips.

D. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or “wrap lock” are not permitted to support or secure conduit system. Fasten conduit with the following material:

1. Wood screws on wood

2. Toggle bolts on hollow masonry

3. Bolts and expansion anchors in concrete or brick

4. Machine screws, threaded rods and clamps on steel

5. Conduit clips on steel joists.

6. 4 inch x 4 inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet.

E. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.

F. Install expansion fittings in metal and PVC conduit as follows:

1. Conduit Crossing Building Expansion Joints:

a. EMT all sizes

b. IMC all sizes

c. RMC all sizes

d. PVC all sizes

2. Conduits entering environmental rooms and other locations subject to thermal expansion are to be installed as required by NEC.

3. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of this green grounding conductors shall be accessible for inspection.

G. Install conduit concealed in walls, partitions and above ceilings. Install conduit exposed in ceiling area (at structure) of boiler rooms, mechanical rooms and in other similar rooms where ceilings are not called for.

H. Install conduit type as shown on plans, concealed in slab when finished areas below do not have ceiling, or where shown on plans. A written approval shall be obtained from Owner/Structural Engineer prior to construction for all such installations. Conduits embedded in structural slabs shall be installed in the middle of the slab below the top and above the bottom reinforcing steel. Maintain a minimum concrete coverage of one inch (1") except where penetration is made. Conduit shall emerge from slab vertically, with no bend radius unless concealed in walls.

I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture if cable or wire are not installed immediate after conduit run. Tape covering conduit ends is not acceptable.

K. Provide 200 lb. nylon cord full length in empty conduit.

L. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; pack void around conduit with oakum and fill ends of sleeve with fire-resistive compound or provide mechanical fire-stop fittings with UL listed fire-rating or seal opening around conduit with UL listed foamed silicone elastomer compound equal to fire-rating of floor or wall.

M. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90 degree bends are required, prior approval by the Engineer is required. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bodies shall be readily accessible and sized for the cables installed. Running or rolling offsets are not approved. Use factory long radius elbows for bends in conduit larger than 2-inch size. All parallel bends shall be concentric.

N. Pull string shall be provided full length in conduit designated for future use.

O. WET OR DAMP LOCATIONS

1. Unless otherwise shown, use conduits of rigid steel [IMC].

a. Use galvanized rigid steel or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage; and where cast in concrete walls or floor slabs which have waterproof membranes and where cast in masonry walls. Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable.

2. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, building exterior walls, roofs, or similar spaces; service entrance locations from exterior below grade applications to conditioned spaces.

P. HAZARDOUS LOCATIONS

1. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.

2. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.2 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET

A. Use flathead screws to fasten channel to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings on multi-outlet assembly.

C. Maintain grounding continuity between raceway components to provide a continuous grounding path in accordance with the requirement of NEC.

3.3 INSTALLATION - WIREWAYS

A. Bolt wireways to steel channels fastened to the wall or in self-supporting structure. Install level.

B. Gasket each joint in oil-tight wireway.

C. Mount rain tight wireway for exterior installation in horizontal position only.

3.4 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

C. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in.

D. Locate and install boxes to allow access, minimum 12 inches above ceiling except where space dimensions do not allow.

E. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation. Provide minimum 24-inch separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the two and pack openings with fiberglass.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Do not support junction boxes from the raceway systems. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide listed barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box.

K. Outlet boxes for switch shall not be used as junction boxes.

L. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

O. Set floor boxes level and flush with finish flooring material.

P. Prove tamper resistance receptacles in child care areas, psychiatric, medical facilities and elsewhere as required by NFPA standards or as indicated on the drawings.

3.5 INSTALLATION – CABLE TRAY

A. Installation: In conformance with NEC and NEMA requirements and in accordance with manufacturer's instructions. Arrange cable tray to maintain headroom and present neat appearance. Cables shall be arranged in cable trays in a neat, workmanlike manner.

B. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 10 feet maximum. Trays shall be level with respect to grade plus or minus 1/8-inch per 10 feet or 1/2-inch cumulative. Unless otherwise noted cable trays shall be supported by rigid steel brackets or trapeze type hangers. Hanger materials, including threaded hanger rods, all brackets, and other structural support items shall be per 26 05 29, Supporting Methods and shall have sufficient strength to support the load with a safety factor of at least 3 when all trays are filled to design capacity. Where multiple tiers of cable tray are installed, a minimum of 100-lbs./foot fill for each cable tray shall be used to establish support requirements if limiting factor is the supporting material. In fabricating or installing cable tray supports, holes shall be drilled and cuts made with a saw. Hanger rods shall be of 1/2-inch or larger diameter, shall be double-nutted at the lowest cable tray support and the hanger rod shall be cut off one (1) inch below the bottom nut. Provide threaded rod end cover to protect against accidental contact. Cable tray support spacing shall not exceed 10 feet for ladder type trays. Hanger rods shall be unspliced. Cable trays installed on trapeze type hangers shall be braced laterally at intervals not exceeding 50 feet. Refer to Section 26 05 29 for cable tray support methods.

C. Where it is necessary to make field changes in the tray system, cuts shall be made with hacksaw or power saw. All sharp edges and burrs shall be removed and end covers installed where accidental contact may occur.

D. Install warning signs at 50 foot centers along route of cable tray, in locations visible from the floor.

E. Where new cable trays are installed above, below or in-line with existing cable trays, the new cable tray shall be supported independently from the existing cable tray with new supports and framing unless approved by the Owner and the Structural Engineer. Maintain twelve-inch clearance between cable tray and surfaces with temperatures exceeding 104 degrees F, such as flues, steam pipes, and heating appliances. Maintain at least 6-inch clearance between cable tray and piping, ductwork or other interference. Any deviation from this must be approved by the Owner. It shall be the Contractor's responsibility to protect existing cable tray in the area of

construction against damage throughout the construction period. Any damaged cable tray shall be replaced by the Contractor at no additional cost prior to final acceptance by the Owner.

F. All power cable trays shall have a continuous; No. 4/0 insulated copper, (for aluminum tray) and bare copper (for galvanized steel tray) grounding conductor run inside the tray. Bond No. 4/0 to each section of tray and fitting with an OZ Gedney type CTGC ground clamp. All communication cable trays shall have a continuous, No. 6, green insulated copper grounding conductor run inside the tray. Connect to tray at each fitting or tray section per the Drawings.

G. Maintain electrical continuity between sections of cable tray and bond cable trays at the both ends to building ground plates to provide a continuous grounding path. Install copper braided bonding jumpers around expansion joints and hinged adjustable splice plates where electrical discontinuity occurs.

H. Cable tray in designated "Corrosive" areas shall be fiberglass.

3.6 WALL AND FLOOR PENETRATIONS:

A. Core drilling shall be approved in writing by the Structural Engineer prior to execution. Avoid anchor bolt on structural column by installing “column hugging” type of support channel for electrical installation. PVC shall not be used for wall and floor penetration.

B. Wall penetrations for cable tray or under floor raceway shall be sealed in accordance with the appropriate Fire-Stopping and Joint Sealers Specification Section , .

C. Provide a 3 1/2 inch curb around block outs through concrete floors. Fire-stop per Architectural specification.

D. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. Coordinate roof penetration locations and methods with the roofing contractor.

END OF SECTION

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 26 05 53 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Nameplates, engraving and tape labels

B. Wire and cable markers or color coding

C. Conduit color coding and labeling

1.2 REFERENCES

A. NFPA 70 – National Electrical Code

1.3 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal procedures, and Division 01 for submittal requirements.

1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Equipment Nameplates:

1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.

2. For emergency equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.

3. For UPS powered equipment provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.

4. For fire alarm system provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.

5. For security and CCTV system panels, provide engraved three-layer laminated plastic nameplates with white letters on a blue background.

B. Underground Warning Tape

1. Manufactured polyethylene material and unaffected by acids and alkaline.

2. 3.5 mils thick and 6 inches wide.

3. Tensile strength of 1,750 psi lengthwise.

4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.

C. Conductor Color Coded Insulation

1. Factory applied color coded insulation shall be provided. Cable requirements shall meet requirements of section 26 05 19 Cable Wire and Connector 600V.

D. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2" lettering.

E. Tape Labels: Embossed or laminate adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.

1. White letters on black background for normal power.

2. White letters on red background for emergency/standby power.

3. White letters on orange background for UPS power.

F. J-Box and Cover Plate Voltage Labels: Black stenciled letters 1/4" high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.

G. Spare Conduits Labels: Label spare conduits at both source and termination along with entry into every pull box/enclosure. Label conduit with black permanent marker with identifier “SPARE-XX-YY” Where XX represent the source equipment name or id and YY represents the termination location i.e. room number or equipment id.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Degrease and clean surfaces to receive nameplates or tape labels.

B. Install nameplates parallel to equipment lines.

C. Secure plastic nameplates to equipment fronts using screws or rivets. Use of adhesives shall be per Owner’s approval. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

3.2 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits. Label control wire with number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

B. Conductors for power circuits to be identified per the following schedule.

	System Voltage			
Conductor	480/277V	208/120V		
Phase A	Brown	Black		
Phase B	Purple	Red		
Phase C	Yellow	Blue		
Neutral	Gray	White		
Grounding IG	Green N/A	Green Green w/Yellow		

3.3 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.

B. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4-inch; identify source to device and the load it serves, including location.

C. Dry Type Transformers Not in Substations: 3/8-inch; identify equipment designation. 1/4-inch; identify primary and secondary voltages, primary source, and secondary load and location.

D. Automatic Transfer Switches: 3/8-inch; white letters and red background; identify equipment designation 1/4-inch; identify voltage rating, normal source, standby source and load served including location.

E. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, voltage and bus rating.

3.4 ENCLOSURE COLOR CODING

A. The following systems shall have each junction and pull box cover completely painted per the following:

System	Color of Box Cover
Ethernet Backbone	Blue
Telecommunications	Brown
FCMS	Green
Emergency Power	Red
Security**	White
Fire Alarm	Yellow
Clock	Fluorescent Violet
U.P.S.	Fluorescent Pink

**Security shall include, but not be limited to, the following systems:
- Card Access
- Duress Alarms
- Perimeter Door Alarms
- CCTV

END OF SECTION 26 05 19

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE AND ARC FLASH STUDY

PART 1 GENERAL

1.01 SUMMARY

A. Provide a complete short-circuit and protective device coordination study for the normal and emergency/standby power electrical distribution systems.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the latest edition of NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the latest edition of NFPA70E, Annex D. The arc flash study shall encompass all normal and emergency/standby power electrical distribution systems with the exception, of any equipment as described in paragraph 2.04C.

1.02 SUBMITTALS

A. A preliminary short-circuit study shall be submitted to the design engineer either before or at the same time as the equipment submittals. If equipment submittals such as switchgear, switchboards, panelboards etc. are submitted without a preliminary study, they will be returned as rejected. .

B. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. The report shall include the following sections:
1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided for all equipment described in paragraph 2.04.

1.03 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code.
2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.04 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Licensed Professional Electrical Engineer licensed in the state of Texas and skilled in performing and interpreting the power system studies.

B. The Licensed Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm and have a minimum of five (5) years of experience in performing power system studies.

1.05 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of EDSA, SKM Systems Analysis Power Tools or ETAP, unless approved otherwise.

PART 2 PRODUCTS

2.01 DATA COLLECTION

A. The Contractor shall be responsible for collecting all data for the studies as directed by the Engineer of Record.

2.02 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Provide the following:
1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Tabulations of calculated quantities.
6. Results, conclusions, and recommendations.
7. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a line to ground fault at each piece of equipment/bus as described in 1.01.

B. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings.
   2. Adequacy of all equipment to withstand short-circuit stresses.

C. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

D. Transformer design impedances shall be used only when test impedances are not available.

2.03 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. The phase curves shall be plotted on separate sheets from the ground fault curves.

B. Plot the following characteristics on the TCC graphs where applicable:
   1. Equipment name based on Bid documents.
   2. Electric utility's overcurrent protective device.
   3. Medium voltage (4.16kV and above) equipment overcurrent relay settings.
   4. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   5. Low voltage (480V and below) equipment circuit breaker trip device settings, including manufacturer's tolerance bands.
   6. Transformer full-load current, magnetizing inrush current and ANSI through-fault protection curves.
   7. Ground fault protective devices, as applicable.
   8. Pertinent motor starting characteristics and motor damage points, where applicable.
   9. Pertinent generator short-circuit decrement curve and generator damage point.

C. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.04 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584-2002 equations that are presented in NFPA 70E, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all electrical equipment. Minimum working distances shall be based upon the calculated arc flash boundary considering incident energy of 1.2 cal/cm2.

D. The results of the short circuit calculations (fault values) and protective device coordination study (device clearing times) shall be utilized for use by the arc flash program. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible.

G. For all equipment locations with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

H. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

I. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

J. Arc Flash calculations shall be based on the actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.05 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
1. Feeder input data including feeder type (cable or bus), size and length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit sub-transient reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:
   1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage.
      b. Calculated fault current magnitude and angle.
      c. Fault point X/R ratio.
      d. Equivalent impedance.
   2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage.
      b. Calculated symmetrical fault current magnitude and angle.
      c. Fault point X/R ratio.
      d. Calculated asymmetrical fault currents:
         1) Based on fault point X/R ratio.
         2) Based on calculated symmetrical value multiplied by 1.6.
         3) Based on calculated symmetrical value multiplied by 2.7.
      e. Equivalent impedance.
   3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
      a. Voltage.
      b. Calculated symmetrical fault current magnitude and angle.
      c. Fault point X/R ratio.
      d. No AC Decrement (NACD) Ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

C. Recommended Protective Device Settings:
   1. Phase and Ground Relays:
      a. Current transformer ratio.
      b. Current setting.
      c. Time setting.
      d. Instantaneous setting.
      e. Recommendations on improved relaying systems, if applicable.
   2. Circuit Breakers:
      a. Adjustable pickups and time delays (long time, short time, ground).
      b. Adjustable time-current characteristic.
      c. Adjustable instantaneous pickup.
      d. Recommendations on improved trip systems, if applicable.

D. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   4. Arc flash boundary.
   5. Working distance.
   6. Incident energy.
   7. Hazard Risk Category.
   8. Recommendations for arc flash energy reduction.

PART 3 EXECUTION

3.01 FIELD ADJUSTMENT

A. Submit report to engineer for review. Based upon the Engineer and Utility Provider's review, incorporate comments and required adjustments into final round of adjustments at all devices.

B. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by, or under the direction of the engineering service division of the equipment manufacturer.

C. Making minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies to be coordinated with Engineer of Record and equipment manufacturer.

3.02 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:
1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

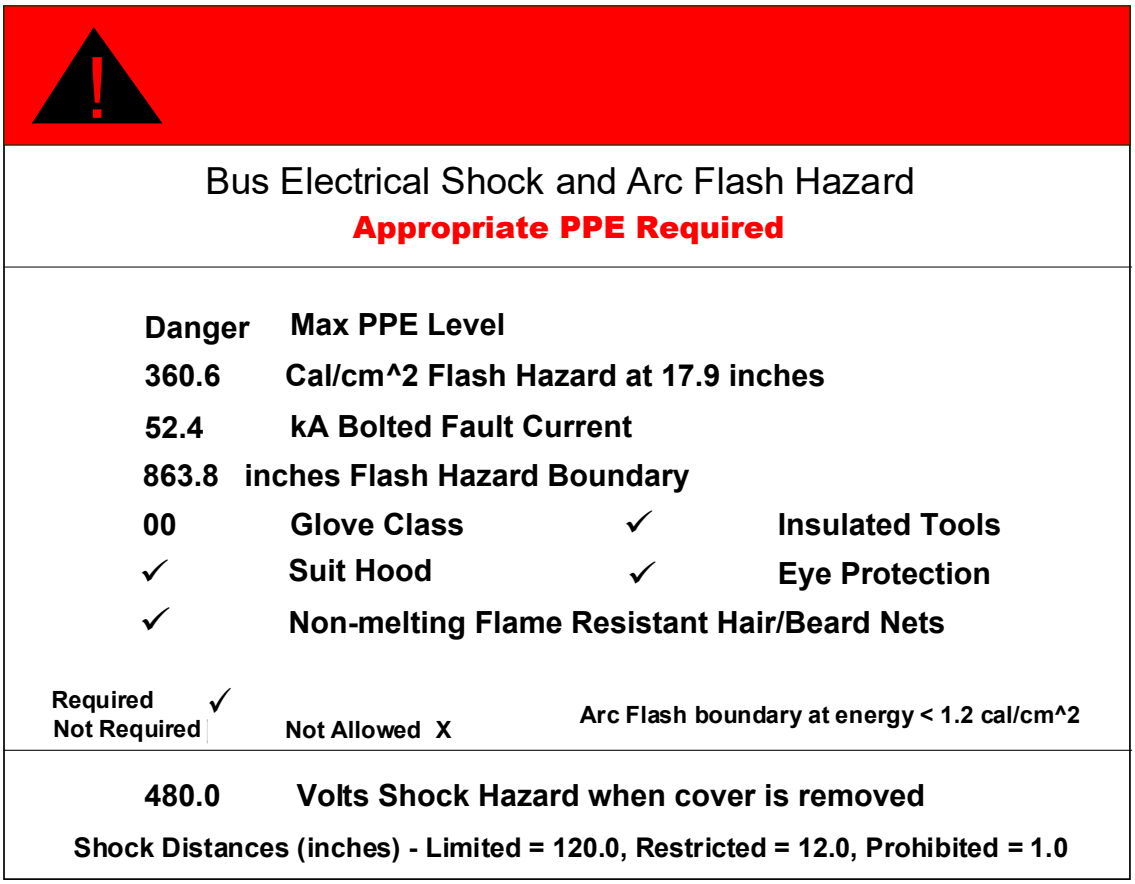
E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. See page 6 for example of arc flash label.
1. For each 480V and 208V panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided for each section.
3. For each low voltage switchboard, one arc flash label shall be provided for each section.
4. For each low and medium voltage switchgear, one flash label shall be provided for each breaker.
5. For medium voltage switches one arc flash label shall be provided

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.03 ARC FLASH TRAINING

The contractor of the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment

(minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.



END OF SECTION

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for Electrical systems, assemblies, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

1.2 RELATED SECTIONS

A. SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

B. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS

C. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

D. SECTION 28 08 00 – COMMISSIONING OF FIRE ALARM SYSTEMS

1.3 DEFINITIONS

A. Refer to section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.4 SUBMITTALS

A. Certificate Of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for details of Electrical contractor’s responsibilities related to commissioning.

B. Attend commissioning meetings.

C. Provide information requested by the CxA for functional testing and for final commissioning documentation.

D. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

E. Functional testing of systems will be carried out solely by Electrical contractor’s personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.6 CxA'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 26 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Electrical systems.

C. Perform commissioning tests at the direction of the CxA.

D. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

E. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

F. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.4 FUNCTIONAL TESTING

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Electrical systems.

B. Provide measuring instruments and logging devices to record test data as directed by the CxA.

3.5 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.6 RE-TESTING

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Electrical systems.

3.7 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for list of Electrical systems to be commissioned.

END OF SECTION

SECTION 26 22 13 - DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Section includes enclosed dry type distribution transformers rated 600 volts and less, sizes up to 500 kVA.

B. Dry type Two-Winding transformers.

C. Dry type Buck and Boost transformers.

D. Dry type Shielded Isolation transformers.

E. Dry type, K-rated transformers.

1.02 REFERENCES

A. NEMA ST 1 - Specialty Transformers (Except General Purpose Type)

B. NEMA ST 20 - Dry Type Transformers for General Applications

C. IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers.

D. IEEE C57.12.91 - Test Code for Dry-Type Distribution and Power Transformers

E. IEEE C57.96 – Guide for Loading Dry-Type Distribution and Power Transformers

F. IEEE Std. 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

G. UL 506 – Specialty Transformers

H. UL 1561 - Dry Type General Purpose and Power Transformers

I. NEMA TP 1 – Guide for Determining Energy Efficiency for Distribution Transformers

J. NEMA TP 2 – Standard Test Method for Measuring the Energy Consumption for Distribution Transformers

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures, and Division 01 for submittal requirement.

B. Submit manufacturer's data on dry type transformers, vibration isolators and accessories.

C. Include outline and support point dimensions of enclosures and accessories; unit weight; voltage; kVA; impedance ratings and characteristics; loss data; efficiency at 25, 50, 75 and 100 percent rated load; sound level; tap configurations; insulation system type, K-rating, and rated temperature rise.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store transformers in a clean and dry space and protected from weather in accordance with manufacturer's instructions. Cover ventilating openings to keep out dust.

B. Transformer shall not be used as work tables, scaffolds or ladders.

C. Handle transformers carefully to avoid damage to material components, enclosure and finish. Use only lifting eyes and brackets provided for that purpose. Damaged transformers shall be rejected and not be installed on project.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Transformers shall be of dry type complying with the design function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.

B. Provide barrel type coils vacuum impregnated with high grade insulating varnish, non-hydroscopic thermo-setting type.

C. Furnish copper windings, continuous without splice.

D. Use non-aging silicon steel cores held together with steel channels or angles, with low flux density, quiet operating, and vibration isolated from enclosure and support channels.

E. All transformers shall be designed, manufactured, and tested in accordance with all the latest applicable ANSI, NEMA, IEEE and UL standards, and shall be UL listed and bear the UL label.

2.02 DRY TYPE TWO-WINDING TRANSFORMERS

A. Acceptable manufacturers

1. Square D
2. Cutler-Hammer/Eaton
3. Siemens
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 01 for substitution requirement.

B. Dry type transformers shall be NEMA ST 20; factory-assembled, air cooled dry type transformers; ratings as shown on the Drawings.

C. Insulation system and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA as follows:

kVA Rating	Insulation Class (degree C)	Temperature Rise (degree C)
1-15 kVA	185	115
25-500 kVA	220	115

D. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degree ambient.

E. Winding Taps, Transformers 15 kVA and Less: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 25 kVA and Larger: Two 2.5 percent above rated voltage and four 2.5 percent below rated voltage, full capacity taps on primary.

G. Sound Levels: Maximum sound levels are as follows:

kVA Rating	Sound Level
0-9	40 db
10-50	45 db
51-150	50 db
151-300	55 db
301-500	60 db

H. Basic impulse level shall be 10 KV.

I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

J. Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be floor mounted.

K. Enclosure shall be NEMA Type 2 or as shown on the Drawings. Provide lifting eyes or brackets.

L. Nameplate on transformer shall include transformer connection data, kVA ratings, impedance, and overload capacity based on rated allowable winding temperature rise. Identify primary and secondary voltages.

M. Isolate core and coil from enclosure using vibration absorbing mounts.

N. Provide identification nameplate in accordance with Section 26 05 53 Electrical Identification.

2.03 DRY TYPE BUCK AND BOOST TRANSFORMERS

A. Acceptable manufacturers

1. Square D
2. Cutler-Hammer/Eaton
3. Siemens
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 01 for substitution requirement.

B. Dry Type Buck and Boost Transformers shall be NEMA ST 1; factory-assembled, dry type two winding buck and boost transformers; ratings as shown on the Drawings.

C. Insulation system and average winding temperature rise for rated kVA as follows:

kVA Rating	Insulation Class (degree C)	Temperature Rise (degree C)
0.25-2 kVA	185	115
3-7.5 kVA	185	115

D. Transformers shall be suitable for wall mount.

E. Enclosure shall be NEMA Type 3R or as shown on the Drawings.

F. Nameplate shall include transformer connection data.

2.04 DRY TYPE SHIELDED ISOLATION TRANSFORMERS

A. Acceptable manufacturers

1. Square D

2. Cutler-Hammer/Eaton

3. General Electric Company

4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 01 for substitution requirement.

B. Dry Type Shielded Isolation Transformers shall be NEMA ST 20; factory-assembled, air cooled dry type shielded isolation transformers; ratings as shown on the Drawings.

C. Insulation system and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA shall be as 2.2 C.

D. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degree ambient.

E. Winding Taps, Transformers 15 kVA and Less: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 25 kVA and Larger: Two 2.5 percent above rated voltage and four 2.5 percent below rated voltage, full capacity taps on primary.

G. Maximum sound levels are as 2.2 G.

H. Basic Impulse Level shall be 10 KV.

I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

J. Transformers shall be supplied with quality, full width electrostatic shields in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:

1. Common mode noise attenuation:

Frequency	Attenuation
0 - 1.5k Hz	120 db
1.5 -10k Hz	90 db
10 - 100k Hz	65 db
100k – 1M Hz	40 db

2. Transverse mode noise attenuation:

Frequency	Attenuation
1.5 -10k Hz	52 db
10 - 100k Hz	30 db
100k – 1M Hz	30 db

K. Provide electrostatic shield between the primary and secondary winding and grounded to the transformer core.

L. Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be floor mounted.

M. Enclosure shall be NEMA Type 2 or as shown on the Drawings. Provide lifting eyes or brackets.

N. Nameplate on transformer shall include transformer connection data, ratings, impedance, and overload capacity based on rated allowable winding temperature rise. Identify primary and secondary voltages.

O. Isolate core and coil from enclosure using vibration absorbing mounts.

P. Provide identification nameplate in accordance with Section 26 05 53 Electrical Identification.

2.05 DRY TYPE, K-RATED TRANSFORMERS

A. K-rated transformers shall be NEMA ST 20; factory-assembled, air cooled dry type transformers meeting all the requirements as specified under paragraphs 2.2 and 2.4 of this Section; ratings as shown on the Drawings.

B. Impedance range shall be 3 percent to 5 percent with a 2 percent minimum reactance in order to reduce neutral current when supplying loads with large amount of third harmonic current.

C. Transformers shall be UL listed and labeled for K-4 or K-13; ratings as shown on the Drawings.

D. Three-phase transformer secondary neutral terminal shall be sized for 200 percent of the rated secondary phase current.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer shall examine the areas and conditions under which dry type transformers are to be installed and notify the contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install dry type transformers as indicated, in accordance with the applicable requirements of the NEC and the National Electrical Contractors Association's "Standard of Installation".

B. Check for damage and tight connections prior to energizing transformer.

C. Measure primary and secondary voltages and coordinate with the engineer of record to make appropriate tap adjustments.

D. Set transformer plumb and level.

E. Use flexible liquid-tight conduit, 2-4 ft. length, for connections to transformer case. Make conduit connections to side panel of enclosure.

F. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

1. For floor or roof transformer installations, use one pad type Korfund Elasto-Grip, waffle, or equal, at each corner of the transformer, sized for load.

2. For wall hung transformer installations, use spring type Korfund Series P, or equal. Provide sound pads at each corner of the transformer, sized for 1/2 inch deflection. Provide structural engineering detail(s) of acceptable support means.

3. For trapeze hung transformer installations provide structural detail(s) of acceptable support means.

G. Avoid mounting transformers in areas that tend to amplify noises into occupied areas, such as stairways, hall areas, and corners near ceilings. Avoid, where possible, nearby reflecting objects or enclosures that might resonate or echo.

H. Ground transformers in accordance with Section 26 05 26 Grounding and NEC requirements.

END OF SECTION

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Furnish and install switchboards as herein specified and shown on the associated electrical drawings.

1.02 REFERENCES

A. ANSI C12.1 - Code for Electricity Metering

B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments

C. ANSI C57.13 - Requirements for Instrument Transformers

D. NEMA AB 1 - Molded Case Circuit Breakers

E. NEMA KS 1 - Enclosed Switches

F. NEMA PB 2 - Dead Front Distribution Switchboards

G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Dead-front Switchboards Rated 600 Volts or Less

H. UL 489 – Molded Case Circuit Breakers and Circuit Breaker Enclosures

1.03 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures, and Division 01 for submittal requirement.

B. Brochures. Submit brochures on the switchboard, main protective device, branch circuit protective devices and instrumentation.

C. Dimensional Drawings. Submit dimensional drawings of the switchboard, including top and bottom views showing entry and exit space for conduits and busways, front and side elevations showing arrangement of all devices and also include dimensional data on all buses including material type and capacity of the buses.

D. Electrical Information. Submit one-line diagrams for equipment being provided. Also submit information on all protective devices including type, ratings and settings of all trips provided including ground fault relay settings.

E. Submit schematics and wiring diagrams for metering and controls.

F. Line-by-line specification review by equipment manufacturer with any exception explicitly defined.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in factory-fabricated water-resistant wrapping, and mounted on shipping skids. All components and sections shall be identified by the Purchaser’s equipment number or name, which shall be clearly indicated on Shop Drawings and shipping packages.

B. Handle in accordance with NRMS PB2.1 to avoid damage to material components, enclosure, and finish. Switchboard shall be provided with adequate lifting means.

C. Store in a clean, dry space and protected from the weather. Maintain factory wrapping or provide an additional heavy canvas or plastic cover to protect units from dirt, water, construction debris, and traffic. Switchboard shall be stored in a location where the relative humidity below required level for storage per manufacturer's recommendation. Heaters shall be energized in the switchboard section when relative humidity exceeds the requirement.

D. Provide one (1) set of installation and maintenance instructions with each switchboard. Instructions are to be easily identified and affixed within the incoming or main section of the line-up.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer/Eaton

B. General Electric Company

C. Siemens

D. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00, and Division 01 for substitution requirement.

2.02 SWITCHBOARD CONSTRUCTION

A. Enclosure

1. Switchboards shall be of the freestanding type complying with the design and function requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data. Completely enclose the frame with removable, bolted, code-gage sheet steel covered panels and hinged doors. Form all cover plates and doors to eliminate sharp edges.

2. Provide factory-assembled, dead-front, metal-enclosed, and self-supporting switchboard consisting of required vertical sections bolted together to form one rigid assembly.

3. Enclosure shall be NEMA Type as per Drawings. Sections shall align at front and rear, or as per configurations shown on Drawings.

B. Access.

1. Provide an assembly that permits access to buses and devices for installation and future maintenance from the front only.

2. Provide adequate wiring gutter space at top, bottom and sides for easy access to all wiring terminations.

C. Device Mounting.

1. Assembly must permit interchanging devices of the same type, rating and method of operation.

2. Main section devices shall be individually mounted.

3. Distribution section devices shall be panel (group) mounted.

4. Auxiliary section devices shall be individually mounted.

D. Lifting Provisions.

1. Provide permanent lifting eyes or hooks on top of shipping sections.

E. Finish. Grind all steel surfaces smooth, with all burrs, sharp edges, welding splatters, loose rust, scale and the like totally removed after fabrication. Following this, chemically clean and treat steel work to allow a good bond between the steel surfaces and apply rust-preventive primer paint. After priming, thoroughly paint the inside and outside with a suitable finish paint. Supply 1 pint of finish paint for each switchboard for touch-up after installation.

F. Line and load terminations shall be accessible from front of the switchboard or as per Drawings.

G. Buses

1. Material. 98 percent IACS conductivity tin-plated copper with round edges.

2. Design.

a. Rate main bus for currents shown.

b. Current rating for section bus and branch bus to be determined on the basis of service to all devices including spares and spaces for future additions. Section bus is to be sized to a minimum of 60 percent of the main bus rating.

c. Size buses to limit their temperature rise within the switchboard to 65°C based on a 40°C outside ambient temperature.

d. Current density of buses shall not exceed 1000 amperes per square inch.

e. Individual phase bus bars to be insulated to withstand 2000 volts a-c for 1 minute.

3. Neutral Bus. In each switchboard section include an un-insulated neutral bus on insulated bus supports secured to the section frame and bolt to neutral bus bars in adjacent sections, thus providing a continuous neutral bus.

4. Ground Bus. In each switchboard section, include an un-insulated copper ground bus bar for the equipment. Secure the bar to the unit frame and bolt to the ground bus bars in adjacent sections, thus providing a continuous equipment ground bus. Arrange the equipment ground bus to ground the switchboard parts that do not carry current. Include terminations at the bus bar for feeder and branch circuit grounding conductors. The terminations must be exothermically welded on or be of an approved pressure connector type. Extend all buses the entire length of the switchboard. Buses must have the required capacity, minimum 1/4”x1” copper ground bus, for their total length. Make provisions for extensions from either end of buses.

5. Insulators. Support main, section and branch bus systems with insulators to provide short circuit bracings. Use non-carbonizing, non-tracking insulators.

6. Bus Arrangement: Phase A-B-C, left to right, top to bottom, and front to rear, as viewed from the front. Provided main horizontal bus with continuous current rating as shown on Drawings. Main bus shall be full capacity through each section and have provisions for future extension. Main bus and sub-main busses shall be sized to meet UL and NEMA standards for temperature rise.

H. Device and Bus Insulation

1. Isolate vertical sections from each other using insulating barriers. Provide insulating barriers between main bus and load terminal.

I. Main Protective Devices

1. Type. As the main protective device for the switchboard, provide a 100 percent rated, 3 pole insulated case circuit breaker. Trip. Stored-energy, quick-make, quick-break type.

2. Mounting. Stationary with bolted connection.

3. Operation. Manual.

4. Trip. Long time, short time, instantaneous and ground fault. The ground fault shall provide an alarm only. Alarm shall be in the form of both local and remote alarm. Local alarm shall be provided via status indicator change of position and audible alarm. Remote alarm shall be provided via dry contact for interfacing with building automation system.

5. Accessories.

a. Mechanical pushbutton trip and indicator.

b. Provisions for padlocking in the open position.

c. Visual indicators showing mode of automatic tripping.

J. All bussing shall be rated for the maximum available fault current as shown on drawings or as determined by the Selective Coordination Study required under Section 26 14 00.Provide disconnecting means of all phases, neutral and grounds either in the form of a link, or similar conducting piece, designed to make connection between two suitable terminals or consisting of a terminal plate or stud provided with a suitable wire connection. Simple removal of bolts from a single bus bar joint is not acceptable.

K. Lugs shall be tin-plated copper.

L. Exterior and interior steel surfaces shall be cleaned and finished with gray enamel over a rust inhibiting phosphatized coating. Color shall be ANSI 61 gray.

M. Switchboard electrical ratings and configurations as shown on Drawings.

N. The switchboard shall be UL listed as suitable for use as service entrance equipment.

O. Pull Box: Same construction as switchboard, size as shown on Drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard. Top or bottom entry as shown on Drawings, which shall be clearly indicated on shop drawings.

P. Pull Section: Same construction as switchboard, size as shown on Drawings. Arrange as shown on Drawings.

Q. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on Drawings.

R. Infrared testing windows. Furnish and install infrared windows in main and distribution sections.

2.03 IDENTIFICATION

A. Nameplates. To identify switches, breakers, and other major devices, provide engraved phenolic nameplates per Section 26 05 53. Mount nameplates on the front of door or panels adjacent to the device, and secure with screws.

B. Legend. Indicate on the nameplate legend the name of the circuit, panelboard, motor control center or equipment served by the device.

2.04 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES

A. Main and feeder protective devices shall be molded case circuit breakers.

1. Breakers 400 ampere frame and less shall be manufacturer's standard industrial construction bolt-on type, integral inverse time delay thermal and instantaneous magnetic trip. Breakers 225 ampere through 400 ampere shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.

2. Breakers 600 ampere frame and above shall be equipped with solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip.

3. Interrupting capacity shall be as noted on Drawings. Refer to Branch Circuit/Feeder Connection schedule and One Line diagram Sheet E-401.

2.05 GROUND FAULT RELAYING

A. Provide ground fault protection on each disconnect device, rated 1200 amps or above.

B. Provide U.L. listed ground fault relay system with coordinated ground sensor with integral test winding and solid state relay to operate with protective device shunt trip circuit and monitor panel.

C. Use time delay type relay with the following features:

1. Continuously adjustable current pick-up settings of 100 to 1200 amperes.

2. Continuously adjustable time delay setting from instantaneous (.03 seconds) to one second.

3. Memory function to recognize and initiate tripping on intermittent ground faults.

D. Install panel that indicates relay operation and provides means for testing the system with or without interruption of electric service and does not permit the ground fault system to be inadvertently left in an inactive or "off" state.

E. Use zero sequence fault arrangement.

2.06 METERING

A. Provide Shark multi-function instruments as shown on Drawings, Shark 100B or other instruments with the following electrical parameters.

1. Voltmeter, phase to phase and phase to neutral.

2. Current, per phase RMS and 3 phase average.

3. Demand current, per phase.

4. Power factor, 3 phase total.

5. Real power, 3 phase total.

6. Reactive power, 3 phase total.

7. Apparent power, 3 phase total.

8. Energy (MWH).

9. Reactive energy (MVARH).

10. Frequency.

11. Average demand real power.

12. Bacnet Connection for remote central monitoring.

B. Current Transformers: ANSI C57.13; 5-ampere secondary, window type with single secondary winding and secondary shorting device, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

C. Voltage Transformers: ANSI C57.13; 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install switchboards as indicated in accordance with manufacturer's written instructions and applicable requirements of the NEC, NEMA, ANSI and applicable requirement of the National Electrical Contractors Association's "Standard of Installation".

B. Switchboard shall be bolted directly to floor without the use of floor sills.

C. Provide a foundation pad for the switchboard as specified in Section 26 05 00, Electrical General Provisions. Secure the switchboard to the pad as recommended by the manufacturer. Include openings for bottom feeds that are compatible with the equipment provided.

D. Tighten electrical bus connections with torque wrench to manufacturer's recommendations.

E. Connect phase A, B and C, respectively to Bus No. 1, 2 and 3 from left to right or top to bottom.

F. Adjust operating mechanisms for free mechanical movement.

G. Restoration. Restore all damaged surfaces to factory finish.

H. Inspection. Thoroughly inspect the switchboard for items such as loose connections and presence of foreign materials and remedy prior to energizing the switchboard. All bolted connections shall be torqued to the manufacturer's recommendations.

I. Double Lugging. Double lugging on one protective device to feed two separate loads is not permitted.

3.02 TESTING

A. Infrared testing

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. After installation and before acceptance by the Owner, the Contractor shall provide the services of an independent testing organization to performance test breaker and/or relays in accordance with the NEC. This test shall involve passing a primary current through the current sensor with a suitable, low voltage test set and timer, which shall allow verification of their published curves and that they actually trip the devices on which they are applied. This test shall also include the polarity of the current sensors and give an indication of satisfactory operation of the solid-state power meter.

C. Notify the Owner of this test date 5 days in advance so the tests can be properly witnessed.

END OF SECTION

SECTION 26 24 16 – PANELBOARDS – DISTRIBUTION AND BRANCH CIRCUIT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies the requirements for all panelboards including electronic grade panelboards.

1.03 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. NEMA AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.

2. NEMA AB 3 – Molded Case Circuit Breaker and Their Application

3. NEMA PB 1 - Panelboards.

4. NEMA PB 1.1 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

5. Federal Specification W-P-115C – Panel, Power Distribution.

6. W-C-375B – Circuit Breakers, Molded Case; Branch Circuit and Service.

7. National Fire Protection Association NFPA 70 – National Electrical Code.

8. NFPA 780 – Installation of Lightning Protection Systems.

9. Underwriters Laboratories UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

10. UL 67 – Panelboards.

11. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

12. UL 943 - Ground-Fault Circuit-Interrupters.

13. UL 1449 3rd Edition - Surge Protective Devices.

14. The specified Electronic Grade Panelboards (EGP) shall be designed, manufactured, tested, and installed in compliance with the following standards, in additional to requirements listed above:

    a. American National Standards Institute and The Institute of Electrical and Electronics Engineers ANSI/IEEE C62.41 - Guide for Surge Voltages in Low-Voltage AC Power Circuits.

    b. ANSI/IEEE C62.45 - Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

    c. Federal Information Processing Standards Publication 94 - Field Grounding and Shielding Application.

1.04 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures, and Division 01 for submittal requirement

B. Product Data:

1. Submit manufacturer's product data for panelboards and circuit breakers including but not limited to:

    1) Lug types

    2) Wire range for submitted lugs

    3) Accessories

C. Record Documents:

1. Submit dimensioned Drawings showing size, circuit breaker and equipment arrangement and ratings, including but not limited to, voltage, single or three phase, main bus ampacity, circuit breaker short circuit ampere rating, trip type, cable entry arrangement (top or bottom), neutral bus rating, temperature rating of circuit breakers..

2. Equipment arrangement must include panelboard schedules. Panelboard schedules must be identical to the schedules in the project documents unless there is a technical reason for a deviation. Reasons for any deviation shall be included in the Submittal.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver panelboards in factory-fabricated water-resistant wrapping.

B. Handle panelboards carefully to avoid damage to material components, enclosure and finish.

C. Store in a clean, dry space and protected from the weather.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D Company

B. Cutler Hammer/Eaton

C. Siemens

D. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 01 for substitution requirement.

2.02 PANELBOARD CONSTRUCTION

A. General: Provide flush or surface mounted, or surface mounted dead front circuit breaker type distribution or branch circuit panelboards with electrical ratings and configurations, as indicated on the drawings and schedules. Load center types of panelboards are not acceptable.

B. Enclosure:

1. Enclosure shall be proper NEMA type as shown on the drawings.

2. NEMA 1

a. Back box shall be galvanized steel for flush mounted branch circuit panelboards. Back box shall have gray enamel electro-deposited finish over cleaned phosphatized steel for all other type panelboards.

b. Provide cabinet front with full-height hinged door. Cabinet front shall be cleaned and finished with ANSI 49 or ANSI 61 gray enamel over a rust-inhibiting phosphatized coating. One door over the interior and an additional hinged dead front cover over interior and wireway (door-in-door). Full-height front cover hinged to box with concealed trim clamps. Provide flush door locks.

C. Where power monitors or metering are specified on the Drawings, the manufacturer shall cut the doors for field mounting of the unit.

D. NEMA 3R, 3S and 12 enclosures and doors shall have gray enamel electro-deposited finish over cleaned phosphatized steel.

1. Doors shall be gasketed and equipped with tumbler type vault lock and two trunk latches where required by UL standard. Interior trim shall consist of four pieces, each covering one gutter top, bottom and both sides.

E. Doors shall be gasketed and equipped with tumbler type vault lock and two trunk latches where required by UL standard. Interior trim shall consist of four pieces, each covering one gutter top, bottom and both sides.

F. Construct cabinet in accordance with UL 50. Use not less than 16-guage galvanized sheet steel, with all cut edge galvanized. Provide a minimum 4-inch gutter wiring space on each side. Provide large gutter where required to accommodate the size and quantity of conductors to be terminated in the panel, and where required by code.

1. Exterior and interior steel surfaces shall be cleaned and finished with gray enamel over rust inhibiting phosphatized coating. Color shall be ANSI 61 gray.

2. Doors shall be equipped with flush-type combination catch and key lock. All locks shall be keyed alike.

3. Branch circuit panelboards shall be 5 ¾ inches deep.

4. A directory holder with heavy plastic plate, metal frame, and index card shall be mounted inside of each door.

5. Reinforce enclosure and securely support bus bars and overcurrent devices to prevent vibration and breakage in handling.

6. Rating: Minimum integrated short-circuit rating, voltage and current rating as shown on drawings.

7. Labeling:

A. The Contractor shall furnish and install engraved, laminated plastic nameplates on the trim per Section 26 05 53., ELECTRICAL IDENTIFICATION

b. Provide arc flash labeling per NFPA 70E and Section 26 05 73.

G. Bus:

1. Provide panelboards with rounded edge phase, neutral and ground buses, rated full capacity as scheduled on drawings. Buses shall be full-length copper and braced for the maximum available fault current as shown on drawings. Neutral bus shall be 200% rated for those panels feeding non-linear loads as determined by the Engineer of Record.

2. Phase bussing shall be stacked front-to-back, A-B-C.

H. The neutral and ground bus bars shall have termination locations for each of the individual feeders and the lugs sized appropriately. In addition, space shall be provided to terminate the neutrals and grounds in two feeders equal to the largest size circuit breaker that can be installed in the panelboard.

I. The ground bus shall be mounted in the panelboard, opposite the incoming line and neutral lugs and shall be accessible to allow easy installation of bolts, nuts and lock washers used to attach ground lugs. The neutral and ground buses in branch circuit panelboards shall have spaces to terminate 42 neutral and 42 ground wires or the same number as the number of spaces provided in the panelboard, whichever is greater.

J. All lugs for phase, neutral, and ground buses shall be tin-plated copper.

K. Lugs shall be rated for CU/AL.

L. Panelboard shall be rated SE where required for Service Entrance duty.

M. Panelboard boxes (cans) shall be galvanized steel with all cut edges galvanized.

N. Provide panelboards with factory installed knockouts or without factory installed knockouts. Conduit knockouts shall be made in the field. contractor to designate.

A. Provide compression connectors where conductors terminate directly to bus. (MLO panels).

2.03 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES

A. Provide molded case circuit breakers with manufacturer's standard construction, bolt on type, with integral inverse time delay thermal and instantaneous magnetic trip in each pole. Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits.

B. Circuit breakers shall have an over center, trip-free, toggle operating mechanism that will provide a quick-make, quick-break contact action.

C. Provide handle padlock attachments on circuit breakers where indicated on drawings. Device shall be capable of accepting a single padlock. All circuit breakers shall be capable of being individually padlocked in the off position.

D. The circuit breakers shall be connected to the bus by means of solidly bolted connection. In multi-pole breakers, the phase connections on the bussing shall be made simultaneously without additional connectors or jumpers. Multi-pole breakers shall be two or three pole as specified. Handle ties are not permitted. The circuit breaker shall have common tripping for all poles.

E. All circuit breakers shall be provided with visible ON and OFF indications.

F. Provide GFCI and AFCI circuit breakers as indicated on drawing and per NEC requirement.

G. Heat Maintenance. Circuit breakers serving heat maintenance system for plumbing hot water piping, fire protection, or similar systems shall be single-pole or 2-pole as indicated on drawings, GFCI-type with ground fault trip for protection of equipment.

H. Provide handle ties as required to comply with NEC requirement for common disconnect of multi-wire branch circuits.

I. Breaker voltage and trip rating shall be per drawings. Breaker faceplate shall indicate UL certificate standards with applicable voltage systems and corresponding short current rating as per drawings.

J. Molded Case Circuit Breakers:

1. Breakers 400 ampere frame and less shall be manufacturer's standard industrial construction, bolt-on type, integral inverse time delay thermal and instantaneous magnetic trip. Breakers 225 ampere through 400 ampere shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.

2. Breakers 600 ampere frame and above shall be equipped with solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip.

K. Current Limiting Molded Case Circuit Breakers:

1. Breakers 100 ampere frame shall be inverse time delay thermal and instantaneous magnetic trip.

2. Breakers 250 ampere and 400 ampere frame shall be solid-state trip with built-in current transformers, solid-state trip unit and flux transfer shunt trip.

3. Current limiting breakers shall protect downstream molded case breakers. Submit manufacturer's test data proving the protection, from both peak currents and I^2T energy of downstream devices.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions and the applicable requirements of the NEC, NEMA, ANSI and the National Electrical Contractors Association's "Standard of Installation".

B. Install panelboards flush- or surface-mounted, as indicated on drawings and schedules. Anchor enclosure firmly to cross members in walls and structural surfaces, ensuring that they are permanently and mechanically secured. Direct attachment to drywall is not permitted. Freestanding distribution panelboards shall be installed on metal racks structurally capable for the equipment or on a concrete housekeeping pad with anchors per manufacturer's recommendation.

C. Mounting height:

1. Distribution Panelboards: As per Drawings, but such that highest operating handle is no greater than 79 inches above finished floor.

2. Branch Circuit Panelboards: As per Drawings, but such that highest operating handle is no greater than 79 inches above finished floor.

3. Where panelboards occur in groups, the tops shall be aligned if it can be done without exceeding items 1 and 2 above.

D. Install panelboards plumb. Adjust trim to cover all openings. Seal all conduit openings and cap all open knockout holes.

E. Provide blank plates for unused open spaces in panelboards. Keep the front door closed after work to protect from damage, dirt, and debris at all times.

F. Install identification nameplates in accordance with Section 26 05 53, Electrical Identification.

G. In addition to conduits serving circuits indicated on plans and schedules, stub 5 empty one-inch conduits out of each recessed panelboard to an accessible location above ceiling. Extend conduit stub a minimum of 8 inches into accessible location and cap to prevent trash from entering conduit.

3.02 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

B. Provide testing and start-up as indicated in Section 26 08 00 – Commissioning of Electrical Systems.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3.03 PANELBOARD SCHEDULE

A. The Contractor shall provide engraved, laminated plastic nameplates for circuit identification as indicated on the Drawings for panelboards.

B. The Contractor shall fill the index directory inside the front door of branch circuit panelboards identifying each circuit as shown on Panel Schedule drawings. Where changes are made, the schedule shall reflect the changes. At the end of the job, these schedules shall reflect as-built record conditions.

C. Each panelboard schedule shall include the following information:

1. Panelboard No.: Panelboard identification name/number as assigned on drawings.

2. Room No.: Room number in which panelboard is located.

3. Served From: Number of transformer or distribution panel that feeds panelboard.

4. Date Published: Date panelboard information was published.

5. Circuit Number: Each circuit number identified.

6. Description: Identify circuits by equipment served and by room numbers, where room numbers exist. Indicate equipment name (e.g., printer, VAV box, security cameras) if applicable, or device type (e.g., Receptacle, I.G. Receptacle, Floor Box, Furniture, SPD). Circuits serving more than one room shall indicate only the room in which the homerun commences.

7. Indicate spares and spaces with light, erasable pencil marking.

D. Provide electronic copy to Owner's representative of all panelboard schedules as part of the closeout documentation.

END OF SECTION 26 24 16

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

C. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

D. Provide factory fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated provide proper selection to correspond with branch circuit wiring and overcurrent protection.

1.2 SUMMARY

A. This Section specifies the requirements for wiring devices, including wall switches, receptacles, device plate covers, wall dimmers, and occupancy sensors.

1.3 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. NEMA WD 1 - General-Purpose Wiring Devices.
2. NEMA WD 5 - Specific-Purpose Wiring Devices.
3. Americans with Disabilities Act (ADA).
4. ANSI/UL 20 - General Use Snap Switches.
5. ANSI/UL 498 - Attachment Plugs and Receptacles.
6. ANSI/UL 943- Ground Fault Circuit Interrupters.
7. NFPA 70 - National Electrical Code (NEC).
8. Texas Accessibility Standards (TAS).
9. Americans with Disabilities Act (ADA).
10. ANSI/IEEE 62.41 - Guide for Surge Voltages in Low-Voltage AC Power Circuits.

11. ASHRAE 90.1-2013 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.4 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures, and Division 01 for submittal requirements.

B. Product Data:

1. Submit manufacturer's product data for all wiring devices and device plates.

2. Occupancy Sensor Shop Drawings

3. Day light harvesting shop drawings.

a. Shop drawings indicating occupancy sensor type, quantity, coverage, field of view and location and quantity of power packs. Shop drawings shall be provided on 1/8" scale drawing with device types clearly identified by use of a legend.

b. Shop drawings shall clearly identify the locations and specification of any auxiliary contacts.

c. Shop drawings shall include sequence of operations for all occupancy sensors types and installations.

4. Submit shop drawings on 1/8" scale drawings for the following systems:

a. Surface mounted raceway systems as identified in the drawings.

b. Poke-throughs and floor-boxes.

1) Clearly indicate model number, finish and trim of floor-boxes and poke throughs.

2) Poke throughs and floor-boxes shall be dimensioned for coordination of rough in.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

2.2 WALL SWITCHES

A. Type: Specification grade, quiet type, back and side wired switches as specified herein. Switch terminal screws shall be designed to accommodate No. 10 AWG stranded conductor.

B. Rating: 20 amperes, 120/277 volts.

C. Listing: UL 20 and Federal Specification W-S-896.

D. Finished Areas. Wall switches shall be toggle-style switches. Select device plates of same color, and match with receptacle, phone and data outlet device plate style. Coordinate with Architect and Owner for room finish.

E. Manufacturers: Provide devices in the color as specified herein.

Type	Pass & Seymour	Cooper	Leviton	Hubbell
S	PS20AC1	AH1221	1221-2	HBL1221
S2	PS20AC2	AH1222	1222-2	HBL1222
S3	PS20AC3	AH1223	1223-2	HBL1223
S4	PS20AC4	AH1224	1224-2	HBL1224

1. Color shall be white

2. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120/277 volt AC with number of poles as required.

3. Key operated switches shall be 20 amperes and 120/277 volt AC with number of poles as required. Key locks alike. Furnish keys compatible with key switch, quantity as directed by Owner, minimum of ten copies.

4. Switches for lighting circuits and motor loads under 1/3 hp shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.

5. A listed manual switch having a horsepower rating not less than the rating of the motor, a thermal overload element suitable for the motor served, and marked "Suitable as Motor Disconnect", shall be permitted to serve as the disconnect means for stationary motors of 1/4 horsepower or less.

6. Use horsepower rated switches, with thermal overload element, approved for motor control or disconnect service when controlling or disconnecting motor loads in excess of 1/4 hp. Horsepower rated switches shall be 30 ampere minimum, with number of poles as required.

7. EPO. Illuminated Emergency-Power-Off (EPO) switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or accepted substitution.

8. Switch terminal screws or connectors shall be designed to accommodate up to No. 10 AWG stranded conductor.

2.3 RECEPTACLES

A. Type: Industrial Grade devices shall be provided throughout unless otherwise identified on the drawings.

B. Rating: Scheduled on Drawings.

C. Listing: UL 498 and Federal Specification W-C-596.

D. Provide devices in the color as specified herein.

NEMA Configuration	Pass & Seymour	Cooper	Leviton	Hubbell
5-20R (Duplex)	8300	8300	8300	HBL8300
5-20R (Single)	8301	8310	8310	HBL8310
5-20R (Tamper Resistant)	TR63-H	TR-8300	8300-SG	HBL8300SG
GFCI	2095-HG	VGFH20_	N7899-HF	GFR8300H

1. Color designation Shall be white.

E. Provide corrosion resistant devices where installed in wet locations and damp locations and other areas as required per NEC.

F. Heavy Duty Locking-Blade Receptacles. NEMA WD 5. Locking-blade receptacles shall be heavy duty specification grade.

G. Ground Fault Circuit Interrupter (GFCI). GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter.

1. End of Life. GFCI receptacles shall include End-of-Life protection, such that when the GFCI device is incapable of passing the internal self-test function, and can therefore no longer provide ground fault protection, the GFCI receptacle will either render itself incapable of delivering power, or indicate by visual or audible means that the device must be replaced

2. Reverse Line-Load Mis-wire. GFCI receptacles shall include reverse line-line protection, such that the GFCI device will deny power to the receptacle face if it is mis-wired with the connections to the line and load terminals reversed.

3. Listing. UL 943, current edition.

4. Do not use feed through feature.

5. GFCI receptacles are required throughout the building within 6 feet of sinks, including lab areas.

6. Each GFCI device shall control only one receptacle.

7. Where receptacle is installed in damp or wet locations provide weather resistant type GFCI receptacles.

H. Specific-use receptacles shall have volts, amps, poles, and NEMA configuration as noted on Drawings.

I. Weatherproof Receptacles. Receptacles specified or indicated as "weatherproof" shall be mounted in a cast steel box with gasketed, weatherproof device plate as specified. Provide weatherproof, gasketed device covers suitable for continuous connection of cord-and-plug devices. See paragraph 2.5E, this Section.

J. Automatic Controlled Receptacle.

1. All nonlocking-type, 125 volt, 15 and 20 ampere receptacles that are controlled by an automatic control device or incorporate control features that remove power from the top portion of the outlet for the purpose of energy management or building automation shall be marked with the symbol indicated in paragraph 2.3.I.2 of this Section placed on the split controlled receptacle outlet where visible after installation. Color shall be green.

2. Receptacle identifier 

2.4 DEVICE PLATES

A. Exposed Boxes in Dry Interior Spaces:

1. Manufacture plates of heavy cadmium-plated sheet steel.

2. Edges of plates must be flush with edges of boxes.

B. Other Areas:

1. Use weatherproof device plates.

2. Provide cast plates with gasketed spring door covers for protection of device.

C. For outlets and switches, provide labeled nameplates listing power source and circuit number. Example: P10 for panel “P” circuit “10”. Label to be tape type black letters on white for normal power and red on white for all generator/emergency circuits.

D. Covers for outlets outdoors shall be weatherproof while in use and meet the requirements of latest NEC.

2.5 DEVICE COLOR

A. All switches shall be white except as follows:

B. Normal power receptacles shall be white.

C. Split energy controlled switches shall be green.

D. Isolated ground receptacles shall be orange

2.6 WALL DIMMERS

A. Wall dimmers shall be linear slide type equal to Lutron Nova Series.

B. Dimmers shall be compatible with dimmable lighting as specified.

C. Dimmers with pre-set scenes shall contain manual dimming as well.

D. 0-10V current sink dimmers must be coordinated with the dimming ballasts and drivers. Where ballasts and drivers do not go off at a minimum voltage, provide a separate relay or switching device to completely remove voltage and turn the drivers and ballasts completely off. The relay and switching device can be provided as part of the slide dimmer if the entire device is listed as a complete assembly.

E. Manufacturers

1. Lutron.

2. Leviton.

3. Hubbell

4. nLite

5. Lutron

6. Other manufacturers as specifically approved in writing by Owner.

2.7 LIGHT OCCUPANCY SENSORS

A. Lighting occupancy sensors shall be installed as a functioning system per the Contract Documents and manufacturer’s installation instructions.

B. Required commissioning shall be completed prior to Substantial Completion.

C. Ultrasonic motion detectors shall not be used in vivarium corridors.

D. Occupancy sensors shall be dual technology with learning capability.

E. Provide auxiliary contacts as required for proper functioning of lighting control system, automatic load control of receptacles in areas identified by AHSRAE 90.1, and as indicated in the Drawings.

F. Manufacturers

1. Wattstopper.

2. Novitas.

3. Hubbell

4. nLite

5. Lutron

6. Other manufacturers as specifically approved in writing by Owner.

2.8 TELECOMMUNICATION, A/V, AND SECURITY OUTLETS

A. Telecommunication, AV and Security outlets, boxes, sleeves and conduit are part of this Contract.

B. Provide conduit as indicated in Telecom, A/V and Security Drawings. In the absence of conduit sizes and quantities being indicated in the Telecom, A/V and Security Construction Documents, provide outlet boxes and 1-inch conduit with connector and bushing to accessible location above the ceiling source panel or device as indicated in Telecom, A/V or Security Construction Documents.

C. Provide a pull string in each conduit and tie off pull string above ceiling.

D. For floor outlets, provide 1-inch conduit to accessible location above the ceiling on the floor served by the outlet. .

2.09 FIRE RATED POKE THROUGHS

A. Install poke through devices per manufacturer requirements.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Deliver wiring devices individually wrapped in factory-fabricated containers.

B. Handle wiring devices carefully to avoid breaking, scoring, and damage to material components, enclosure and finish. Damaged products shall be rejected and not be installed on this project.

C. Store wiring devices in a clean, dry space, elevated above grade, and protected from weather, dirt, sunlight, and moisture.

3.2 INSPECTION

A. Examine the areas and conditions under which wiring devices are to be installed and notify the Owner and the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of the work. Include a written plan for correction of deficiencies and conditions noted. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 DEVICE COORDINATION

A. Where items of equipment are provided under other Sections, by other Divisions, or by the Owner, provide a compatible receptacle and device plate for the cap or plug, and cord of the equipment.

3.4 GENERAL

A. Install wiring devices in accordance with applicable requirements of the NEC, NEMA, ANSI, and the product manufacturer recommendations.

B. Taps, Splices and Connections. Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends. Refer to Section 26 05 26, Grounding and Bonding.

C. Termination. Stranded conductors for branch circuit wiring to snap switches and receptacles shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer's recommendations. Refer to Section 26 05 19, Insulated Conductors.

D. Where more than one device occurs in one outlet box, such that the voltage between adjacent devices would exceed 300 volts, provide a barrier for isolation to comply with the requirements of NEC Article 404.8(B).

E. Location. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough in, subject to the approval of the Constructor Inspector and the Owner's Representative.

3.5 COORDINATION. COORDINATE LOCATION, MOUNTING HEIGHT, AND ORIENTATION OF WIRING DEVICES WITH ADJACENT OUTLETS FOR OTHER SYSTEMS SUCH AS HVAC CONTROL, TELEVATION, VOICE/DATA, SECURITY, FIRE ALARM, ETC. REFER TO ARCHITECTURAL ELEVATIONS TO VERIFY DIMENSION OF DEVICE LOCATIONS.

A. Preparation. Contractor must examine the areas and conditions under which wiring devices are to be installed and notify the Owner’s Project Manager in writing of conditions detrimental to the proper and timely completion of the Work.

B. Inspect devices for physical damage.

C. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.6 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Wall switch and receptacle ground wiring shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer's recommendations

D. Wall receptacles shall be installed with the ground pinhole in the up position, unless instructed otherwise by the Owner. Where installed horizontally, the ground pinhole shall be installed at the left side.

E. The approximate location of switches and receptacles are indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the architectural Drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Owner's Project Manager.

F. Install wall switches 48 inches above finished floor, OFF position down.

G. Install wall dimmers 48 inches above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.

H. Where wainscot is near the 48 inch level, install device in the wall below the top edge of the wainscot and as near the 48 inch level as possible to provide the most pleasing appearance. Do not partially install devices in the wainscot and partially in the wall.

I. Where shown the strike side of doors, install switches and dimmers not less than 2 inches and not more than 12 inches from door trim, but in all cases as close to the 2 inch setback as possible.

J. Verify all doors swings before rough-in and locate switches and dimmers on strike side of door wherever possible.

K. Position the center of convenience, telephone, computer and TV outlets 18 inches above floor or 8 inches above countertops unless otherwise noted. Coordinate with equipment and architectural Drawings. Install outlets vertically on walls and horizontally above countertops.

L. Install specific-use receptacles at heights shown on Drawings.

M. Install poke through devices per manufacturer requirements, including but not limited to:

1. UL requirements for maximum density in structural bays and minimum spacing between poke through devices.

2. Final installation for all devices shall be ADA compliant.

3. Properly seal poke through devices where installed above non-conditioned spaces to minimize the passage of unconditioned air into the space through the poke through device.

4. Device gangs not used by electrical, A/V and telecom shall remain blocked off for future use.

5. Properly clean the inside of the poke through device.

6. Properly label the devices installed within the poke through device.

N. Install occupancy sensors per manufacturer requirements.

O. Coordinate with owner representative and Engineer of Record for programming of sensors with regards to line of sight and programmed delay.

3.7 DEVICE PLATES

A. Type. Provide device plates for each outlet of the type required for service and device involved. Plates shall be provided for telecom and A/V per those documents.

B. Plates shall be thermal plastic.

C. Ganged Devices. Mount ganged devices under a single, one-piece device plate.

D. Workmanship. Install devices and device plates level, plumb, and parallel to adjacent surfaces or trim. Devices shall be flush with the finished trim cover plates. Device plates shall be tight to surfaces over which they are installed.

E. Patching. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the Contractor to patch, paint, etc. around the opening to the satisfaction of the Owner's Representative.

F. Engraving. Engrave plates with 1/8-inch-high black letters, if designated for engraving.

G. Labels. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, provide plates with labels to identify items being controlled, or areas being lighted. Refer to Section 26 05 53 for Electrical Identification requirements.

END OF SECTION

SECTION 26 28 13 - FUSES, 600 VOLT

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Dual-element, current limiting Class R fuses for loads up to 600 volts, 0-600 Amps.

B. Time delay, current limiting Class L fuses for loads up to 600 volts, 601-6000 Amps.

1.02 REFERENCES

A. UL 248-12 - Standard For Safety For Low-Voltage Fuses-Part 12: Class R Fuses

B. UL 248-10 - Standard For Safety For Low-Voltage Fuses-Part 10: Class L Fuses

C. Where application of local codes, trade association standard or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00,Basic Electrical Requirements, 260100 Submitttal Procedures and Division 01 for submittal requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store fuses in a clean and dry space and protected from weather. When necessary to store outdoors, elevate materials well above grade and enclose with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.01 MATERIAL AND EQUIPMENT

A. Furnish fuses manufactured by Buss, or equal, in accordance with the following:

1. Motors and Transformers, 0 to 600 Amp:

    a. 250 volt - Buss LPN-RK, UL Class RK1.

    b. 600 volt - Buss LPS-RK, UL Class RK1.

2. Lighting Loads, 0 to 600 Amp:

    a. 250 volt - Buss KTN-R, UL Class RK1.

    b. 600 volt - Buss KTS-R, UL Class RK1.

3. All Applications, 601 to 6000 Amp:

    a. 600 volt - Buss KRP-C, UL Class L.

B. Size fuses serving motor loads as specifically recommended by motor or equipment manufacturer or in the range of 150% to 175% of motor nameplate rating per NEC in accordance to the type of motor.

C. Interrupting Rating: 300,000 RMS Amps.

D. Maintenance Stock, Fuses:

1. Furnish the following:

    a. Three spare fuses of each size and type for a spare set.

b. Furnish spare fuse cabinet sized to contain required spare fuse stock.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install fuses where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC, national and local codes, regulations, and requirements.

B. Provide quantity of spare fuses and fuse cabinet per the requirement of this Section at the location per drawing or the direction of Owner’s Representative, in addition to replace blown or defective fuses during installation, startup, system commissioning and acceptance.

END OF SECTION

SECTION 26 28 16 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Disconnect switches, fusible and non-fusible.

B. Enclosures.

1.02 REFERENCES

A. Federal Spec. W-S-865 - Switch, Box (Enclosed), Surface-Mounted.

B. NEMA KS 1 - Enclosed Switches.

C. NFPA 70 - National Electrical Code

D. NFPA 70E - Electrical Safety Requirement for Employee Workplaces

E. UL 98 - Enclosed Switches.

F. NEMA KS 1 – Enclosed Switches

1.03 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedure, and Division 01 for submittal requirement.

B. Submit manufacturer's product data, including lug types. Submit dimensioned drawings and equipment ratings for voltage, capacity, horsepower, and short circuit.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.

B. Handle switches carefully to avoid damage to material components, enclosure and finish. Damaged switches shall not be installed on project.

C. Store switches in a clean and dry space and protected from weather.

PART 2 - PRODUCTS

2.01 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

A. General Electric Company.

B. Square D Company.

C. Cutler Hammer/Eaton

D. Siemens.

2.03 FABRICATED SWITCHES

A. NEMA KS 1; Type HD quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Handle lockable in ON position for service entrance disconnect. Provide defeater so that qualified personnel can open door while switch is in the closed position.

B. Use switches that have number of poles required as per drawings.

C. Switches shall be Underwriters' approved for duty shown and enclosure type per drawings. NEMA [3R/4X] switches shall be provided where exposed to weather. NEMA [3R/4X] switches shall have weatherproof threaded hubs for all conduit entries into switch.

D. Use fuse clips that are rejecting type to accept Class RK or L fuses only.

E. Identify switches, as to equipment served, with engraved laminated plastic plates. Refer to 26 05 53 Electrical Identification.

F. Provide arc flash label per 26 05 73 Overcurrent Protective Device and Arc Flash Study.

G. Voltage rating: 240VAC or 600VAC as per drawings.

H. Where disconnect switch is installed between a VFD and motor, provide normally open, integral auxiliary contacts for shutdown of VFD prior to opening of disconnect switch.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer shall examine the areas and conditions under which safety and disconnect switches are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF SAFETY AND DISCONNECT SWITCHES

A. Install safety or disconnect switches, where required by NEC, where indicated on drawings, and where required by equipment manufacturer, in a location convenient for maintenance on switch and adjacent equipment.

B. Provide fused disconnect switches, whether or not indicated on drawings, when required to maintain equipment manufacturer’s warranty. Coordinate with Division 23 for warranty requirements of equipment approved by submittal.

C. Install fuses in fusible disconnect switches. Provide permanent marking inside switch enclosure for fuse type.

D. Wall mount switches, where possible, or mount on unistrut supports.

END OF SECTION

SECTION 26 41 00 – LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. System design.

B. Air terminals, interconnecting conductors, and other system components and accessories.

C. Grounding and bonding for lightning protection.

D. System inspection and certification.

1.02 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for lightning protection systems.

1. Section 26 00 00 - Basic Electrical Requirements

2. Section 26 05 33 – Raceways, Conduit, and Boxes

3. Section 26 05 26 - Grounding

B. In the event of conflict involving requirements of lightning protection systems between this Section and any other Sections, the provisions of this Section shall govern.

1.03 APPLICABLE CODES AND STANDARDS

A. The materials and installation shall conform to the minimum requirements and latest revisions of the following codes, standards and regulations wherein they apply:

1. NFPA 70 - National Electrical Code

2. UL 96 - Lightning Protection Components

3. UL 96A – Installation Requirements for Lightning Protection Systems

4. NFPA 780 - Lightning Protection Systems

5. LPI 175 - Standard of Practice for the Design - Installation - Inspection of Lightning Protection Systems

6. Texas Department of Insurance (TDI)

1.04 SYSTEM DESCRIPTION

A. Lightning Protection System: UL 96A Master Labeled system consisting of air terminals on roofs, roof mounted mechanical equipment, stacks, bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors. Lightning protection systems shall be incorporated into the building system by the lightning protection contractor as required for a complete master labeled system.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment with minimum three years documented experience and member of the Lightning Protection Institute.

B. Installer: The Contractor for the work covered by this specification shall be recognized as being regularly engaged in the design and installation of lightning protection systems. The Contractor must have minimum three years documented experience and member of the Lightning Protection Institute (LPI). Installer shall be a certified LPI master installer of lightning protection systems.

1.06 COORDINATION

A. Coordinate the work of this Section with concrete, roofing and exterior and interior finish installations.

B. Coordinate all provisions for down conductors and system connections with all trades.

1.07 SUBMITTALS

A. Provide submittals for the following information in addition to and in accordance with Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures, and Division 01 for submittal requirement.

1. Shop drawings showing layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

2. Shop drawings shall include locations of conductors, roof penetrations, floor penetrations, etc., and their compatibility with provisions made during the construction. Once the contract has been established the Contractor shall make a review of provisions being made for the system installation and comment, in writing, with changes or compliance within two weeks of finalizing the contract. Contractor shall coordinate locations of conductors in walls and all penetrations with the appropriate trades: Failure to coordinate these requirements shall not relieve lightning protection Contractor from properly completing its work. This Contractor shall employ the proper trades to provide the chases in walls and roof and floor penetrations required to install the conductors if not coordinated before the floors, walls and roof are installed.

3. Indicate the size and strands needed for all conductors.

4. Product data showing dimensions and materials of each component, and include indication of listing in accordance with UL 96.

5. As Built Record Drawings: The Contractor shall maintain a master set of As Built Record Drawings that shows changes and any other deviations from the Base Drawings in accordance with Section 26 00 00.

6. Documentation of compliance with requirements of Texas Department of Insurance for windstorm rating for location of installation.

7. Copy of UL Master Label Certifications in O&Ms

1.08 MASTER LABEL

A. The system design shall equal to or exceed the requirement of UL 96A for a Master “C” Label. Upon completion, the lightning protection systems shall be inspected by a representative of

Underwriters Laboratories, Inc. The lightning protection systems must pass UL inspection and wear UL label.

1.09 WARRANTY

A. Provide a warranty for material and installation per Section 26 00 00, Basic Electrical Requirements, unless a longer warranty period is required in specific product specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. The system provided under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design.

B. Materials used in connection of the installation of the lightning protection system shall be proved for lightning protection systems by UL. No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversized conductors shall be used.

C. Where a mechanical hazard is involved, conductor size shall be increased to compensate therefore, or suitable protection shall be provided. The conductors may be protected by covering them with molding or tubing made of nonmetallic material.

D. Aluminum materials may not be used except on roofs that utilize aluminum roofing components. When aluminum materials are used, provide all materials of aluminum composition to ensure compatibility, except down conductors and grounding. Provide copper down conductors with bimetal transition at the roof assembly rated for the application.

2.02 CONDUCTORS

A. Except where shown or specified to be aluminum, lightning protection conductors shall be copper and designated as being 98 percent conductive when annealed. Conductor minimum sizes are listed in Tables 3-4 and 3-5 of NFPA 780. Main conductor and secondary conductor cable sizes shall be the same. Where conductors are placed in contact with aluminum building materials such as parapet wall cap or siding, provide aluminum conductors. Copper conductors shall be minimum of 29 strand. Aluminum conductors shall be a minimum of 17 strand. Counterpoise grounding conductors shall be annealed tin copper.

B. Air terminals shall be nickel-plated solid copper with tapered bullet point tips (in lieu of sharp point tips). Minimum air terminal size shall be 5/8-inch diameter by 24 inches long. Where air terminals longer than 24 inches are required, solid copper rods of the appropriate length with threaded ends may be securely attached to the air terminals for extensions. Provide a three-leg tripod brace for each air terminal at an open roof location. Secure the triangular brace to the roof in a manner approved by the roof vendor. Other air terminals shall have a bipod brace. Conductor connections to air terminals shall be bolted.

2.03 GROUND ROD

A. A ground ring (i.e., counterpoise) system shall be installed under Section 26 05 26, Grounding and Bonding. The extent of the ground ring system is indicated on the Drawings. Connect lightning protection system down-leads to the ground ring. New ground rods shall comply with

the requirements listed in Section 26 05 26, Grounding and Bonding. Material exposed to ground shall be annealed tin plated copper.

2.04 CONNECTIONS

A. Make below-ground and concealed connections with exothermic welded connections.

1. Visible connections for roof applications and test wells shall be made with cast bronze bolted pressure connectors which use stainless steel or silicon bronze bolts. All other connections shall be exothermic welded.

2. Connectors shall be:

a. Thompson No. 424B (4-inch parallel clamp) for conductors.

b. Thompson No. 702 bonding plate

c. Thompson No. 637 cross-run clamp, or similar heavy-duty clamps.

d. Equivalent clamps by other manufacturers.

e. Use stainless steel. Bronze materials shall be used to connect to aluminum products or structures, such as exposed metallic stacks.

3. Fittings. Shall, except cable holders, be heavy-duty made from bronze castings. Pressure plates made from stamped or pressed metal parts, or fittings utilizing crimp-type pressure devices will not be allowed. Bolts, screws, and related type hardware shall be stainless steel.

4. Transitions. Make transitions from aluminum to copper conductors using approved, UL-Listed AL-to-CU connectors approved for the purpose and conductors to be joined or spliced.

5. Connections to steel beams shall be Cad Welded.

2.05 ROOF PENETRATIONS

A. Roof penetrations shall be accomplished with through-roof fittings specially designed for this purpose. Through-roof fittings shall utilize solid rods with appropriate hardware. Fittings shall incorporate a positive means for sealing around the rod.

2.06 SURGE PROTECTION DEVICES

A. Coordinate with switchgear or service entrance equipment supplier for selection and installation of surge protection device suitable for use at service entrance and as required to obtain UL 96A Master Label.

PART 3 - EXECUTION

3.01 GENERAL

A. Design and install a complete lightning protection system consisting of air terminals, conductors, connectors, attachments, grounding and necessary appurtenances to comply with minimum requirements listed in the referenced standards. The system shall be installed in a neat workmanlike manner and without interfering with other building systems.

B. Provide a coordinated installation of the lightning protection system and the grounding system. Refer to Section 26 05 26 for Grounding and Bonding.

3.02 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original factory packaging.

B. Handle material carefully and per manufacturer's instructions to avoid damage.

C. Store in a clean dry space and protected from weather, moisture, mud, and damage.

3.03 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on the shop drawings.

C. Beginning of installation means installer accepts existing conditions.

3.04 PROTECTION OF SURROUNDING ELEMENTS

A. Protect elements surrounding work of this Section from damage or disfiguration.

3.05 CONDUCTORS

A. Install in accordance with manufacturer's instructions. Conceal down conductors. Concealed down conductors shall be installed in continuous insulating PVC raceways. Metallic raceways shall not be used. Down lead conductors shall be copper.

B. PVC conduit shall not be installed in plenums. If PVC conduit has to be installed in plenum space, the PVC conduit shall have fire rated walls installed creating a chase space for the conduit.

C. Provide conductor loop for lightning protection system at building roof(s). Bond conductor loop to down-lead conductors. Bond air terminals and roof equipment to conductor loop in accordance with this Section. Where conductor loop is placed in contact with aluminum building materials such as parapet wall cap or siding, transition to aluminum conductor or provide all-aluminum conductor(s) for roof loop.

D. Secure conductors to the roof or other structure at a maximum interval of 3 feet.

E. Conductor Installation: Shall be hidden from street view wherever practical. Main down-leads and roof risers shall be concealed within the building columns or walls. Concealed leads shall be run in continuous, insulating PVC raceways from above roof to 24 inches below finished grade, with no conductor splices or connections. Metallic raceways, fittings, etc. that would form electrically inductive chokes shall not be used.

F. Where loop conductors at roof are aluminum, connect to loop using aluminum conductors with approved connectors, then transition to copper conductors when no longer in contact with aluminum building materials such as parapet wall cap or siding.

G. No bend of a conductor shall form an angle beyond 90 degrees nor shall have a bend radius less than 8 inches per NFPA 780.

3.06 AIR TERMINALS

A. Air terminal height and support shall be in compliance with the requirement of NFPA 780.

B. Air terminals shall not be mounted such they have to be moved to perform maintenance on the equipment they protect.

C. Air terminal shall be designed and installed to withstand wind speeds for location of installation in compliance with Texas Department of Insurance (TDI) Wind Speed requirements.

3.07 GROUND RODS

A. A ground ring (i.e., counterpoise) system shall be installed under Section 26 05 26, Grounding and Bonding. The extent of the ground ring system is indicated on the Drawings. Connect lightning protection system down-leads to the ground ring. New ground rods shall comply with the requirements listed in Section 26 05 26, Grounding and Bonding.

3.08 GROUND RING ELECTRODE

A. A ground ring electrode encircling the building or structure shall be installed. Lightning protection system's down conductors shall be connected to the ground ring electrode.

B. Interconnect lightning protection ground ring electrode with building ground electrode system.

A. ROOF CONNECTIONS Except where specified or shown to use aluminum conductor, make direct connections to lightning protection system with copper conductor for roof mounted equipment, enclosures, mast, and fan stacks. Provide bonding jumpers across equipment mounting isolators and ductwork isolators to provide a complete ground path.

B. Bond roof air terminals to lightning protection system down-lead conductors or conductor loop.

C. Bonding. Metallic objects and systems at roof levels, elsewhere on the structure, and conductive members of the structure shall be completely bonded. Metallic vent pipes at roof that do not extend further than 9 inches above the roof level do not require bonding, except as required to receive a UL-Master Label.

1. Primary bonds for metal bodies of conductance shall be bonded with appropriate fittings and full-size conductor and shall consist of, but not be limited to, the following: roof exhaust fans, fresh air intakes, antenna masts for TV, metal stacks, etc.

2. Metal bodies of inductance located within six feet of a conductor or object with primary bond, shall be bonded with secondary cable and fittings. Typical of these are: roof flashings, parapet coping caps, gravel guards, isolated metal building panels or siding, roof drains, down spouts, roof ventilators, exterior balcony handrails, lower level miscellaneous metals, etc.

D. All antennas shall be grounded.

3.09 ROOF ATTACHMENT AND PENETRATIONS

A. Roof penetration. Contractor shall inform Owner's representative, in advance, of any required roof penetrations and shall obtain approval. Wherever the system penetrates the roof, approved through-roof fittings or sleeves shall be furnished by the lightning protection contractor and installed by the roofing contractor. All patching masonry and structural work shall be furnished and installed by the general contractor.

B. All attachments to roofs must be in strict accordance with the roof manufacturer's recommendations.

1. Submit details of roof attachments and penetrations to the appropriate roof manufacturer for approval prior to installation.

2. Once the lightning protection system installation is complete, engage the appropriate roof manufacturer to inspect roof attachments and penetrations on that manufacturer's roof.

3. Subsequent to this inspection, the roof manufacturer shall furnish the Owner with a letter indicating that lightning protection system component roof attachments and penetrations are satisfactory and that such attachments and penetrations will not reduce the manufacturer's warranty on the roof.

4. Fees for services or inspections provided by the roof manufacturer to accomplish the above related requirements shall be at the expense of the Contractor.

C. Occupied areas. In general, lightning protection system down-leads and other conductors shall not be routed through occupied spaces or through the ceiling or plenum-space above occupied areas. Through-roof penetrations into ceiling spaces or plenums above rooms or areas intended for occupation shall not use exposed down-leads or conductors. Through-roof penetrating assemblies and associated down-leads and conductors above occupied areas shall completely enclose the lightning protection assemblies, components, and conductors in PVC raceway.

3.10 COVER-UP INSPECTION

A. Prior to cover-up of concealed components and connections, notify the Owner so that a cover-up inspection can be performed. Correct any deficiencies prior to concealment of components and connections.

3.11 INSPECTION AND MASTER LABEL

A. Upon completion, the lightning protection systems shall be inspected by a representative of the Owner.

B. The Contractor shall provide inspection and corrective services for the lightning protection system to receive a UL 96A Master "C" Label. The inspection shall cover all points of the lightning protection system, and shall include the following.

1. Conformance to standards and specifications.

2. Completeness of installation.

3. Quality of workmanship.

4. System integrity.

5. Conductors and system components securely fastened and protected against mechanical displacement.

6. Continuity testing of conductors, bonds, and connections.

7. System resistance to ground.

8. Other requirements as stipulated by the Owner at the time of inspection.

C. If the system does not pass UL inspection, the Contractor must make corrections to the system in order to pass inspection.

D. Certification. Installation of the system shall be certified as correct in accordance with these specifications. Master Installer shall certify in writing on Form LPL-175A, covering jobsite witness

of Grounding connections, and at completion of job on Form LPI-175B covering post-installation inspection that system is complete as specified. Contractor shall furnish Owners with above Certificates of LPI Code Compliance, together with UL Master Label "C" Certificate. Job will not be accepted without these Certificates

E. Provide UL Master Label in O&Ms for Owner records.

3.12 CONFLICTS

A. In the event a conflict exists between this specification and any of the referenced standards, the requirements of referenced standards govern. Necessary variances or corrections shall be made at the expense of the lightning protection contractor in order to obtain UL Master Label.

END OF SECTION

SECTION 26 51 00 - INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Interior lighting fixtures and accessories

B. Exterior lighting fixtures and accessories

C. Emergency lighting units

D. Emergency exit signs

E. Emergency fluorescent lamp power supplies

F. Lamps

G. Ballasts

H. Site lighting poles

I. Lighting controls

1.02 REFERENCES

A. NEPA 101 - Code for Safety to Life from Fire in Buildings and Structures

B. NEMA WD1 - General-Purpose Wiring Devices

C. ANSI C82.1 - Specification for Fluorescent Lamp Ballasts

D. Light Emmiting LED DriversUL 924 - Emergency Lighting and Power Equipment

E. NEMA WD 1 - General Color Requirements for Wiring devices

F. NEMA LE 5B – Procedure for Determine Luminaire Efficacy Ratings for High-Intensity Discharge Industrial Luminaires

G. NFPA 70 – National Electrical Code

H. ASHRAE/IES 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings

I. Standards For State-Funded Outdoor Lighting Fixture – Texas House Bill 916 (1999)

J. UT System OFPC – Security Planning and Design Guidelines (2002 release)

1.03 **DESIGN** CRITERIA

A. Lighting level design shall be per latest IESNA (Illuminating Engineering Society of North America) recommendation.

B. The power consumption for interior and exterior lighting shall not exceed power allowance as per ASHRAE 90.1 or IECC, latest adopted revision.

C. Outdoor lighting for state-funded project shall meet “cutoff luminaire” criteria set forth by Texas House Bill 916 (1999).

D. Design for exterior lighting shall meet security criteria required by UT System OFPC – Security Planning and Design Guidelines (2002 release).

1.04 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, 260100 Submittal Procedures and Division 1 for submittal requirement.

B. Submit manufacturer's data on interior and exterior lighting fixtures in booklet form, with separate sheet for each fixture, assembled by luminaire "type" in alphabetical order, with the proposed fixture and accessories clearly labeled.

C. Submit dimensioned drawings and performance data including complete photometric test data for each luminaire, candlepower distribution curves in two or more planes, candlepower chart zero to 90 degrees, lumen output zonal summary chart, average and maximum brightness data, and coefficients of utilization for zonal cavity calculations, , spacing to mounting height ration, efficiency and visual comfort probability. Also provide luminaire weights, mounting data, and accessory information for each luminaries type.

D. LED Lamps: Catalog cuts showing voltages, colors, approximate hours life, approximate initial lumens, lumen maintenance curve, lamp type and base.

E. DRIVERS: Catalog cuts showing type, wiring diagram, nominal watts, input voltage, starting current, input watts, sound rating, power factor and low temperature characteristics.

F. Site lighting pole data and catalog cuts, including wind loading, complete dimensions and finish.

G. Shop drawings for site lighting luminaries showing pertinent physical characteristics, including fastening details, ballast type and location.

H. Controls: Catalog cuts and/or shop drawings showing dimensions, voltage capacity, contact ratings, wiring diagrams, operating levels, and temperature ratings.

I. LED: Provide documentation for performance of LED luminaires including LM 79, LM 80 reports and L70, L80 or L85 test results. Provide documentation for listed tolerances for variation in temperature color, or "binning". Binning documentation shall include MacAdam steps diagram with range of binning clearly indicated. Provide testing data that clearly indicates listed environmental conditions for installation of luminaire including ambient temperature.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers. Parabolic louvers shall be shipped in thermally sealed polyethylene wrapper.

B. Handle lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures.

C. Store lighting fixtures in a clean, dry space and protected from the weather.

PART 2 – PRODUCTS

2.01 GENERAL

A. Lighting fixtures and accessories shall comply with the design and functional requirements of the project. Design characteristics shall be as noted in manufacturer's submittal data.

B. Provide lighting fixtures of the size, type and rating as scheduled, complete with, but not limited to, lamps, lamp holders, reflectors, ballasts, poles and wiring.

2.02 INTERIOR LIGHTING FIXTURES

A. LED

B. Light Emitting Diodes (LED) or Solid State Lighting

1. Provide luminaire package with temperature variance limited to one MacAdam step as defined in ANSI C78.377, “Specifications for the Chromaticity of Solid-state Lighting Products”.

2. Provide luminaire that is factory tested as a complete package with a LM-79 and LM-80 report.

3. Provide luminaire with individual LED boards. Replacement of individual LED boards shall be capable to be performed in the field and shall not require replacement of the entire unit or fixture.

4. Provide fixture with minimum 5 year warranty covering complete luminaire package.

5. Provide LEDs with phosphorous coating, for creation of white LEDs, at the individual LEDs and not at the luminaire lens or housing.

6. Provide luminaire with quick disconnect for LED drivers and individual LED boards.

C. Reflector Finishes

1. Painted Finishes: Provide electro-statically applied dry polyester white powder coat finish with minimum reflectance of 88 percent on all light reflecting surfaces.

2. Specular/Semi specular Finishes: Provide Alzak-type anodized finish on aluminum louvers and reflectors as specified in Luminaire Schedule as shown on the drawings. Minimum reflectivity shall be:

a. Specular: 80 percent

b. Semi-specular: 75 percent

D. Nationally Recognized Testing Laboratory Listing

1. All Luminaries and components shall be tested, listed, and labeled by an OSHA Nationally Recognized Testing Laboratory (NRTL).

2. Luminaries installed under canopies, roofs, or similar damp or wet locations shall be NRTL listed and labeled as suitable for damp or wet locations.

3. Recessed luminaries installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall be approved for the installation in a fire-rated ceiling.

2.03 EXTERIOR LIGHTING FIXTURES

A. Enclosures shall be complete with gaskets to form weatherproof seal and NRTL approved for wet locations.

2.04 BATTERY BACKED EMERGENCY LIGHTING INVERTER UNITS

A. Acceptable Manufacturers

1. Meyers
2. Dual-Lite
3. Lithonia
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

B. General Requirements

1. Provide emergency lighting connected to inverter and buffers o provide automatic emergency lighting upon failure of normal power.
2. Battery shall be 6 or 12 volts, sealed maintenance free, nickel cadmium- type, 24-watt rated capacity, with 1.5 hour minimum capacity to supply the connected lamp load.
3. Charger shall be solid state capable of maintaining the battery fully charged during normal conditions, and capable of recharging discharged battery to full charged within 24 hours.
4. Unit housing shall be thermoplastic or steel with finish as scheduled.
5. Provide test switch to manually transfer unit from normal supply to battery supply.
6. Unit shall be 120 or 277 volt.

2.05 EXIT SIGNS

A. Acceptable Manufacturers

1. Dual-Lite
2. Lithonia
3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

B. General Requirements

1. Provide red LED with red diffuser exit signs at the locations per drawings. Exit signs shall have stencil face, 6-inch high [red][green] letters on white background, or as specified otherwise, with [red Chevron type directional arrows as indicated on drawings.
2. Exit signs shall be provided with remote inverter backup power supply, including power failure relay, test switch, AC ON pilot light, battery, and fully-automatic charger. Provide test switch to manually transfer unit from normal supply to battery supply.
3. Battery shall be sealed maintenance free, nickel cadmium type, 6 or 12 volts, 24-watt rated capacity, with 1.5 hour minimum capacity to supply connected lamp load.
4. Unit shall be 120 or 277 volt.

2.06 LAMPS - LED

A. Acceptable Manufacturers

1. General Electric Company

2. Philips Lighting Company

3. Osram Sylvania

4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 1 for substitution requirement.

2.07 LIGHTING POLES

A. Lighting poles shall be metal, type and finish as specified in Luminaire Schedule as shown on the drawings.

B. Site lighting poles and fixture combination shall meet wind load rating per Texas Department Insurance Windstorm requirements, if applicable.

C. Pole foundation design shall be per A/E. Refer to pole base details as shown on the drawings for specific pole base requirements.

D. The entire pole assembly shall be designed to withstand a steady wind load rating requirements per applicable building code and a gust factor of 1.3 without permanent deflection.

E. Anchor bolts shall be fabricated from commercial quality hot rolled carbon steel bar with guaranteed minimum yield strength of 55,000 psi. Bolts shall have an "L" bend on one end and be galvanized a minimum of 12" on the tread end. Furnish four bolts and bolt setting template with each set of anchor bolts. Furnish one hex nut, 2 hardened steel washers, and one hex nut with a stainless steel locking pin with each bolt. Furnish two leveling shims with each anchor bolt set.

F. Standard finish for pole and accessories shall be a factory applied polyester thermosetting powder coating electro-statically applied to the surface of the substrate to a minimum thickness of 3 mil. Color as specified.

G. Provide and install pole base covers on all poles. Each pole to have internal grounding lug and ground rod.

2.08 LIGHTING CONTROL

A. Refer to Section 26 27 26 Wiring Devices and Floor Boxes for lighting switch, dimming control, and occupancy sensor.

B. Photocell shall be automatic dawn on, dusk off switching; moisture, temperature, and vibration-resistant die-cast aluminum housing; time delay feature to prevent false switching; field adjustable to control operating levels.

PART 3 - EXECUTION

3.01 INSPECTION

A. Prior to ordering lighting fixtures, check the building electrical system requirements, architectural finishes, and the type of ceilings that lighting fixture will be installed. Any discrepancies of compatibility pertaining to trim, frames, color, mounting, ballast, voltage and etc. shall be brought to the attention of A/E by written notice. Do not proceed with procurement until discrepancies are resolved in a satisfactory manner.

B. Installer shall examine the areas and conditions that light fixtures are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF LIGHTING FIXTURES

A. Install light fixtures in accordance with the manufacturer's written instructions, the requirements of the NEC and applicable codes, standard, and regulations. Install lamps in accordance with manufacturer's instructions.

B. Install luminaries at locations as shown on the Drawings; Installed fixtures shall be aligned, aimed, and leveled. Install fixtures in accordance with manufacturer's installation instructions complete with mounting accessories, trim and support materials. Fasten fixtures securely to structural support members of the building; solid pendant fixtures shall be plumb.

C. Coordinate with other crafts to avoid conflicts between luminaires, supports, fittings and mechanical equipment.

D. Surface Mounted Fixture:

1. Mount with support rails attached to ceiling suspension support system, provided ceiling system has been certified to be suitable to support weight of fixtures.

2. Where ceiling system has not been certified to support weight of fixtures, fixtures shall be supported at four points near each corner of fixtures.

3. Provide a minimum 5/8" air space between the fixture and the ceiling.

E. Recessed Fixtures:

1. Handle specular/semi-specular louvers and down light cones using only new clean white cotton or silk gloves. Do not touch louvers or cones with bare hands. Leave luminaries clean and free of any visible dust, debris, or fingerprints with all lamps operational at time of acceptance of work.

2. All recessed fixtures shall be supported from building structure above ceiling with galvanized steel wire at not less than 4 points near corners of fixture. Size of wire shall be capable of supporting weight of fixtures.

3. Recessed luminaries' trims shall fit snugly to the mounting surface and shall not exhibit light leaks or gaps. Provide feed-through junction boxes or provide separate junction boxes. All components shall be accessible through the ceiling opening.

4. Connect recessed luminaries to junction box with flexible steel conduit and fixture wire.

F. Pole Mount Lighting

1. Provide in-line fusing at handhole for all pole-mounted luminaries.

2. Provide removable unitized ballast/component tray with separable connector in all pole-mounted luminaries.

3. Construct base of concrete with dimension and depth as noted on the drawings.

4. Install anchor bolts with minimum projection above top of bases, as specified by pole manufacturer. Ground as indicated on drawings.

5. Mount standards on bases plumb and true utilizing shims as necessary. Grout thoroughly between base-plate and foundation.

6. Touch up chips and scratches on poles (to match new finish) upon completion.

G. Lighting Fixtures Adjustment

1. Adjust to illuminate intended areas as directed.

2. Adjust exterior fixtures during hours of darkness.

H. Immediately before final observation, clean all fixtures, inside and out, including plastics and glassware, and adjust all trim to properly fit adjacent surface, replace broken or damaged parts, and lamp and test all fixtures for electrical as well as mechanical operation.

I. Protect installed fixtures from damage during the remainder of the construction period.

J. Upon completion of installation of interior lighting fixtures, and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION

SECTION 27 10 00 - STRUCTURED CABLING SYSTEM

CAT 6 BASE BID

PART 1 - GENERAL

1.01 This section identifies the requirements, technical design, and specifications for the structured cabling system at the University of Texas Rio Grande Valley, located in Edinburgh, Texas ("Owner"). The structured cabling system as specified is an Industry-Standard Category 6 structured cabling system and includes backbone cabling, horizontal cabling and equipment room hardware as specified.

1.02 The Contractor shall provide a Manufacturer's 20-Year Performance Certification for the installed structured cabling system.

1.03 Contractor shall include materials, equipment, and labor necessary to provide a complete and functional structured cabling system regardless of any items not listed or described in this specification or associated drawings.

1.04 Requirements

A. Contractor Experience Requirements

B. Submittal Requirements

C. Acceptable Manufacturers

D. Codes, Standards and Regulations

E. General Requirements

F. System Requirements

G. Testing Requirements

H. Project Closeout Documentation

I. Attachments

1.05 Related Requirements

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 27, and shall be complied with in every respect. The Contractor shall examine all of the items which make up the Contract Documents, and shall coordinate them with the work on the project.

B. Contractor Experience Requirements

1. The Contractor shall be a Leviton Premier Partner or Panduit Certified Installer prior to submitting a bid for the work.

2. The Contractor shall possess all relevant Manufacturer Certifications (i.e. structured cable systems, testing equipment, etc,) for both the company and individual technicians prior to submitting a bid for the work.

3. The Contractor's Project Manager shall be a Registered Communications Distribution Designer (RCDD) and available for all onsite coordination meetings.

4. The Contractor shall have been in business for a minimum of five (5) years.

5. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

6. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

C. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.06 Submittal Requirements

A. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect/Engineer.

2. All submittals shall be submitted in the same sequence as they are listed in the specifications (i.e. product data in the sequence items are listed in the product data section, manufacturer product certifications for company, manufacturer product certifications for installers, etc.). Submittals not in the proper sequence will not be approved.

3. Manufacturer product data sheets for each proposed system component.

   a. For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted. Product data sheets without the part number clearly identified will not be approved.

4. Manufacturer Product Certifications for Company.

5. Manufacturer Product Certifications for Installers.

6. Manufacturer Certifications for testing equipment technicians.

7. Manufacturer Certifications for testing equipment calibration.

8. RCDD Certificate for Contractor's Project Manager.

9. Manufacturer Warranty letter.

10. Documentation indicating that Contractor has been in business for (5) years.

11. Address of Contractor's local office within a 75-mile radius of the project site.

12. Quantity of full time local technicians within a 75-mile radius of the project site.

13. List of five (5) contractor-installed projects of a similar size and scope that have been in operation for at least (1) year. The Contractor shall provide the following

information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

14. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.

15. List of subcontractors performing any work on the project. List shall clearly identify the subcontractor's legal name and address, the scope of work to be performed by the subcontractors and the overall percentage of the project being provided by the subcontractor. If there are no subcontractors performing any work on the project, submit a statement on company letterhead clearly indicating no subcontractors will be performing any work on this project.

PART 2 - PRODUCTS

2.01 General Requirements

A. The following sections specifically list the acceptable equipment types and items for this project.

B. Architect/Engineer will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

C. Proposed equivalent items must be approved in writing by the Architect/Engineer prior to purchase or installation. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

D. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall substitute the appropriate equivalent manufacturer's part number.

E. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished.

F. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.

G. All wiring, equipment, and installation materials shall be new and of the highest quality.

H. Labels on all cabling, materials, and equipment must indicate a nationally recognized testing laboratory.

I. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer which certifies performance characteristics and compliance with ANSI/TIA/EIA 568-C standards.

2.02 Acceptable Manufacturers

A. Fiber Optic Backbone Cable

1. Indoor

a. 9/125µm Single-Mode Plenum Rated 12 Strand Armored

1) Superior Essex Part Number – L40123401

2. Outdoor Underground

a. 9/125µm Indoor/Outdoor Single-Mode 24 Strand Armored

3. OSP Allwave ZWP Singlemode Fiber – Part Number AT-3BE12YT-024

4. Fiber Optic Inner-duct

a. Outdoor (Maxcell)

1) MaxCell 2" 3-Cell, Detectable – 1000 feet spool – Part Number – MXD2003XX1000

2) Carlon Plenum Rated 1-inch Orange Corrugated Inner-duct. Part Number - CF4X1C-5200 (or equivalent)

B. Copper Backbone Cable

1. Indoor

a. Category 3 24 AWG Unshielded Twisted Pair (UTP) Plenum (Gray Sheath)

1) Superior Essex Part Number – 25-Pair – 18-475-36

2) Commscope Equivalent with the Panduit Solution

b. Category 3 24 AWG Unshielded Twisted Pair (UTP) Riser Rated (Gray Sheath)

1) Superior Essex Part Number – 25-Pair – 18-475-33

2) Commscope Equivalent with the Panduit Solution

2. Outdoor Underground

a. Category 3 22 AWG Unshielded Twisted Pair (UTP) Indoor/Outdoor

1) Superior Essex Part Number – 25-Pair – PE 89, 20-062-05

2) Commscope Equivalent with the Panduit Solution

C. Horizontal Cable

1. Category 6 UTP Plenum

a. Network Access (Blue Sheath)

1) Berk-Tek LANmark-6 Part Number – 10136226

2) Commscope Equivalent with the Panduit Solution

b. Wireless Access Points (Orange Sheath)

1) Berk-Tek LANmark-6 Part Number – 10141073

2) Commscope Equivalent with the Panduit Solution

c. Security Access (Green Sheath)

1) Bertek Lanmark-6 Part Number – 10136748

2) Commscope Equivalent with the Panduit Solution

d. Category 6 UTP Flooded

1) Superior Essex OSP-6 UTP Part Number – 04-001-68

2) Commscope Equivalent with the Panduit Solution

D. Copper Cable Termination

1. Category 6 Horizontal Rack Mounted Patch Panels

a. Leviton 1RU 24-Port QuickPort Flat Panel (modular) – Part Number 49255-H24

b. Leviton 2RU 48-Port QuickPort Flat Panel (modular) – Part Number 49255-H48

c. Contractor shall provide jacks to support the modular patch panel. All unused patch panel prats shall be populated for the owners future use.

d. Panduit Mini Com Equivalent

2. Category 6 Modular Jacks

a. Network Access

1) Equipment Room/Telecommunications Room End (Black)

a) Leviton QuickPort eXtreme 6+ CAT 6 Connector – Part Number 61110-RE6.

b) Field End (yellow)

Leviton QuickPort eXtreme 6+ CAT 6 Connector – Part Number 61110-RY6.

c) Wireless Access Equipment/Telecommunications Room and Field end (Orange)

Leviton QuickPort eXtreme 6+ Cat 6 Connector – Part Number 61110-OR6.

d) Security Access Equipment/Telecommunications Room (Green)

Leviton QuickPort eXtreme 6+ Cat 6 Connector – Part Number 61110-GR6.

e) Panduit Mini Com Equivalent

E. Fiber Optic Cable Termination

1. 2RU Fiber Enclosure

a. Leviton Rack Mounted Fiber Optic Enclosure – Part Number 5R2UH-S06

b. Panduit Equivalent

2. 9µm Single-Mode Fiber Adapter Plate

a. Leviton SC/UPC Single-mode 12 fibers, Part Number – FT-DSCAPC6LBLK

b. Panduit Equivalent

3. Fiber Blank Plate

a. Blank Adapter Plate – Part Number 5F100-BLK

4. 9µm Single-Mode SC/UPC Pigtails

a. Leviton SC/UPC Fiber Pigtails - Part Number UPPSC-S03

b. Leviton 12 Fiber Splice Trays – Part Number T5PLS-12F

c. Panduit Equivalent

5. Loose Tube Fiber Fan-Out Kit

a. Corning Fiber Optic Fan-Out Kit, 12-fiber – Part Number – FAN-BT25-12

6. Fiber Optic Splice Case

a. Coyote 6.5-inch x 22-inch Dome Splice Case with (3) LGSTS72 Splice Trays- Part Number – 8006877

F. Copper Cable Termination

1. Building Entrance Terminals

a. Primary Copper Protectors

1) Circa 50-Pair 110 Style Lightning Protection Block – Part Number – 1880ENA1/NSC-50GT1.

2) Circa 240 volt Solid State Module with PTC – Part Number – 4B1FS-240

2. Backbone Cable Termination Panels

a. Rack Mounted Voice Patch Panels

1) Leviton Cat 5e 24-Port Flat 110-Style Patch Panel – Part Number 5G596-U24.

b. Termination Block Kit Components

1) Leviton Cat 6 110-Style Wiring Block, Wall Mount w/ Legs, CAT 6, 50-Pair – Part Number – 41AW1-050

2) Leviton Horizontal Cable Management Trough Part Number – 41CMS-HCM

3) Panduit Equivalent

3. Telecommunications Faceplates with Designation Window

a. 2-Port Single Gang Flush (White)

1) Leviton Plastic Wallplate with ID Window – Part Number 42080-2WS

b. 4-Port Single Gang Flush (White)

1) Leviton Plastic Wallplate with ID Window – Part Number 42080-4*S

c. 8-Port Double Gang Flush (White)

1) Leviton Plastic Wallplate with ID Window – Part Number 42080-8WP

d. Wall Phone Faceplate (Stainless Steel)

1) Leviton Stainless Steel Wall Phone Plate (Recessed) – Part Number 4108W-1SP.

e. Panduit Mini Com Equivalent

4. 2-Port Surface Mount Box (White)

a. Leviton Surface Mount Box – Part Number 41089-2WP

b. Panduit Mini Equivalent

5. 4-Port Surface Mount Box (White)

a. Leviton 4 Port Surface Mount Box – Part Number 41089-4xP

b. Panduit Mini Com Equivalent

6. Blank Insert (White) (Package of 10)

a. Leviton Blank Insert – Part Number 41084-BWB

b. Panduit Mini Com Equivalent

7. 2-Port Surface Mount Box (White)

a. Leviton QuickPort Surface Mount Box – Part Number 41089-2WP

b. Panduit Mini Com Equivalent

8. Blank Insert (White)

a. Leviton QuickPort Blank Insert – Part Number 41084-BWB

b. Panduit Mini Com Equivalent

G. Equipment Racks, Cabinets, Cable Management, and Accessories

1. Two-Post Rack - 19” x 84” Open Frame (Black)

a. Chatsworth – Part Number 48353-703

2. Vertical Cable Managers (Black)

a. Chatsworth Double Sided Vertical cabling Section - Part Number 30095-703

3. Horizontal Cable Managers (Black)

a. Chatsworth Rack Cabling Manager - Part Number 30130-719

4. Horizontal Wire Troughs

a. Chatsworth Wire Trough – Part Number CMUT19

5. Vertical Metered Power Strip for 7’ Equipment Rack

a. Chatsworth Vertical Power Strip with Meter and NEMA input L6-20p Locking Plug Part and output (24) C13, (6) C19 (24) 5-20P - Part Number L2-1E0E3

b. Contractor shall install (1) vertical power strip in each equipment rack.

H. Cable Runway (Ladder Type)

1. Universal Cable Runway

a. 18-inch Chatsworth - Part Number 10250-718

2. Cable Runway Radius Drop, Cross Member

a. 18-inch Chatsworth - Part Number 12100-718

3. Cable Runway Radius Drop, Stringer

a. Chatsworth - Part Number 12101-701

4. Cable Runway Butt-Splice Kit

a. Chatsworth - Part Number 11301-701

5. Cable Runway Junction-Splice Kit

a. Chatsworth - Part Number 11302-701

6. Cable Runway Butt-Swivel Splice Kit

a. Chatsworth - Part Number 10487-701

7. Rack-to-Runway Mounting Kit

a. 15 to 18-inch runway Chatsworth - Part Number 10595-718

8. Cable Runway Elevation Kit for Racks
   a. Chatsworth - Part Number 10506-706
9. Triangular Support Bracket, Aluminum
   a. 12 to 18-inch runway Chatsworth - Part Number 11421-718
10. Wall Angle Support Kit, Cable Runway
    a. 18-inch runway Chatsworth - Part Number 11421-718
11. 90 Degree Runway-Splice Kit
    a. Chatsworth - Part Number 11314-701
12. 45 Degree Runway-Splice Kit
    a. Chatsworth - Part Number 11313-712
13. Foot Kit, Cable Runway
    a. Chatsworth - Part Number 11309-001
14. Vertical Wall Brackets (pair)
    a. Chatsworth - Part Number 10608-701
15. Threaded Ceiling Kit, Cable Runway
    a. Chatsworth - Part Number 11310-001
16. Threaded Rod Cover
    a. Chatsworth - Part Number 11085-001
17. Protective End Caps for Cable Runway
    a. Chatsworth - Part Number 10642-001
18. End Closing Kit, Cable Runway
    a. Chatsworth - Part Number 11700-712

I. Pathway Cable Support

1. Panduit J-Mod Cable Support System
2. Erico – CADDY CAT LINKS J-Hook Series
3. Erico – Caddy Adjustable Cable Support Series
4. Panduit Plenum Rated Hook & Loop (Black)
5. Erico – Caddy Grid Support – Part Number – ATA41 or ATS41

J. Grounding and Bonding

1. Grounding Bus Bar, 20”
    a. Chatsworth - Part Number 40153-020
2. Grounding Bus Bar, 12”
    a. Chatsworth - Part Number 13622-012
3. Cable Runway Ground Strap Kit
    a. Chatsworth - Part Number 40164-001
4. One Mounting Hole Ground Terminal Block
    a. Chatsworth - Part Number 08009-001
5. Two Hole Compression Ground Lug
    a. Chatsworth – Part Number 40162-901
6. #6 AWG Solid Green Insulation Ground Wire
    a. Superior Essex - Part Number 12-018-04
7. #3/0 Stranded Green Insulation Ground Wire
8. Cable Sheath Bonding Clamp

K. Labeling

1. Permanent Labels for Fiber Optic Cables
    a. Brady
    b. Panduit Self Laminating Labels
2. Permanent Labels for Innerduct
    a. Panduit Dome-Top Ty Marker
3. Permanent Labels for Copper Cables
    a. Panduit Self-Laminating Labels
4. Permanent Labels for Backbone Fiber Optic Cables
    a. Panduit Dome-Top Ty Marker
5. Permanent Labels for Patch Panels
    a. Panduit Component Label
6. Permanent Labels for Faceplates
    a. Panduit Component Label

L. Fire Stop

1. STI Spec Seal Part Number

2. 3M Products Part Number

M. Copper Patch Cables

1. Leviton eXtreme Category 6+ SlimLine UTP Patch Cord – Part Number 6D460-xx*. Verify Quantities and lengths with owner prior to purchase.

2. IDF Room – 70% ft Copper Patch Cords / 30% 10 ft Patch Cords.

3. Work Station – 90% 10ft Copper Patch Cords / 10% 25ft Patch Cords

4. Panduit Equivalent

N. Fiber Optic Patch Cables

1. Leviton SC-SC UPC 1 Meter Fiber Optic Patch Cord Part Number - APSSC-S01
2. Leviton SC-SC UPC 2 Meter Fiber Optic Patch Cord Part Number - APSSC-S02

3. Leviton SC-SC UPC 3 Meter Fiber Optic Patch Cord Part Number - APSSC-S03

4. Leviton multimode 50 micron SC-LC UPC 3 Meter Fiber Optic Patch Cord Part Number – 50-D-CL-M03

5. Leviton singlemode SC-LC UPC 3 Meter Fiber Optic Patch Cord Part Number – AP-S-CL-S03

6. Panduit Equivalent

PART 3 - EXECUTION

3.01 Codes, Standards, Regulations

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire

2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)

1. Telecommunications Distribution Methods Manual 13th Edition

2. Outside Plant Design Reference Manual 5th Edition

3. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices

4. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling

5. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Electronics Industry Alliance (EIA)

F. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998

2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998

3. FCC Part 76, Cable Television Service, revised 1998

G. Insulated Cable Engineers Association (ICEA)

1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable

2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors

3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

H. International Electrotechnical Commission (IEC)

I. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System

2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive

3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)

4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code

5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

J. International Organization for Standardization (ISO)

1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)

2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

3. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

4. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

5. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

K. National Cable Television Association (NCTA)

L. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits.

M. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code

2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.

3. NFPA-101, Life Safety Code

4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems

5. NFPA-780, Standard for the Installation of Lightning Protection Systems.

N. National Institute Standards and Technology (NIST)

O. Occupational Safety and Health Administration (OSHA)

P. Telecommunications Industry Association (TIA)

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009

2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009

3. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, 2009

4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2008

5. ANSI/TIA/EIA–569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005

6. ANSI/TIA–569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009

7. ANSI/TIA/EIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012

8. ANSI/TIA/EIA-607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications, 2011

9. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004

Q. U.S. Department of Agriculture (USDA)

1. RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction

2. RUS Bull 1751F-643 (2002) Underground Plant Design

3. RUS Bull 1751F-815 (1979) Electrical Protection of Outside Plant

4. RUS Bull 1753F-201 (1997) Acceptance Tests of Telecommunications Plant (PC-4)

5. RUS Bull 1753F-401 (1995) Splicing Copper and Fiber Optic Cables (PC-2).

6. RUS Bull 345-65 (1985) Shield Bonding Connectors (PE-65)

7. RUS Bull 345-72 (1985) Filled Splice Closures (PE-74)

8. RUS Bull 345-83 (1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)

R. Underwriters Laboratories, Inc. (UL)

1. UL 510 (2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

2. UL 910 (NFPA 262 1990) Applicable Flame Test

3.02 In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify the Architect/Engineer in writing of any such occurrences before purchasing or installing any equipment or materials. The Architect/Engineer will notify the Contractor of any actions required to resolve these

conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications. In the event of any conflicts between Standards and Codes the more stringent shall take precedence.

3.03 General Requirements

A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect/Engineer for direction before proceeding with that part of the work.

B. The Contractor shall be responsible for coordination with other trades to ensure any conflicts or potential conflicts are resolved prior to any work beginning on the project.

C. The Contractor shall install the materials in accordance with these specifications and the manufacturer’s installation guidelines.

D. No deviations from the plans or specifications shall be made without full consent in writing of the Architect/Engineer. The Contractor shall have written approval from the Architect/Engineer for any additional work beyond the Contract Documents prior to beginning such work. If the Contractor does not obtain written approval from the Architect/Engineer prior to proceeding with the work, the contractor shall not be reimbursed for the work.

E. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, walls, roofs, or ceilings.

F. Contractor shall notify the Architect/Engineer a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect/Engineer to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

G. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap cable, etc., and dispose of such items on a daily basis and return the site to the original

state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

H. Equipment and materials installed by the Contractor shall be free of defects and damage.

I. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

J. Contractor shall test all cables prior to installation. By failing to perform this testing operation, the Contractor shall accept the cable as compliant and assume all liability for the replacement of the cable at no cost to the Owner should it be found defective at a later date.

K. Contractor shall maintain a set of working specifications, design drawings, and record drawings to be kept on site at all times and shall update the record drawings with any changes on a weekly basis. Record drawings shall be made available for inspection at the request of the Architect/Engineer.

L. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

M. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

N. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect/Engineer.

O. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

P. Cables shall be properly supported in accordance with industry standards at all times. Improperly supported cables shall be corrected by the Contractor at no cost to the Owner.

Q. Contractor shall be responsible to properly protect information outlets from damage by other trades during construction.

R. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

S. The Contractor shall not install cables in conduits or sleeves without nylon bushings. Cables installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

T. Contractor shall provide labor to install the owner provided contractor installed wireless access point devices. Contractor shall coordinate with the owner the exact mounting location, contractor shall provide and install all wireless access point patch cords. Owner shall provide all wireless devices and mounting brackets.

3.04 System Requirements

A. Quantities listed are for reference only, contractor is responsible for furnishing materials as required to provide a complete and functioning system. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity shall be furnished.

B. Inter-Building Cable Plant

1. Fiber Optic Cable

a. 9 µm Single Mode

1) Contractor shall furnish and install outdoor underground armored fiber optic cables in contractor-furnished and installed Maxcell inner-duct.

a) Each armored fiber optic cable shall be provided installed inside the Maxcell Inner-Duct with a jetline installed with the cable.

2) The Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.

3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.

4) The contractor shall furnish and install:

a) 24 strand outdoor armored fiber optic cable from New IDF Room to the SOM MDF room as indicated on the technology drawings.

b) 24 strand outdoor armored fiber optic cable from New IDF Room to the Splice point located inside the Chase Near the Academic Services Building as indicated on the technology drawings.

c) Provide and install 2- inch 3 cell maxcell as directed in the technology drawings

2. Fiber Optic Termination

a. Contractor shall Fusion Splice the new armored fiber optic strands with fan-out kits as required and place into fiber optic splice cases with splice trays as indicated in the technology drawings.

b. Contractor shall furnish fiber optic enclosures and coupler panels for all fiber optic strands and blank panels for all unused slots.

c. The Contractor shall furnish and install:

1) 2RU fiber enclosure(s) inside new IDF Room as indicated on the technology drawings.

2) 2RU fiber enclosure(s) inside the SOM MDF as indicated on the technology drawings.

3. Copper Cable

a. High Pair Count Cable

1) Contractor shall furnish and install outdoor underground copper cables.

2) The Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.

3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.

4) The contractor shall furnish and install:

a) 25 pair armored copper cable(s) from new IDF Room to the existing SOM Room as indicated on the technology drawings.

b. High Pair Count Termination

1) Building Entrance Terminals

a) The contractor shall terminate all copper cable pairs on contractor furnished and installed building entrance terminals as indicated in the technology drawings.

b) Contractor shall furnish and install all terminals fully populated with surge protection modules.

c) Contractor shall ground and bond all cables and terminals.

d) The Contractor shall furnish and install:

(1) 25 Pair Category 5e Building Entrance Terminal(s) in new IDF Room as indicated on the technology drawings.

(2) 25 Pair category 5e Building Entrance Terminal(s) in existing MDF Room as indicated on the technology drawings.

2) Patch Panels

a) The Contractor shall furnish and install rack mounted voice patch panels.

b) The Contractor shall extend all copper cable pairs from the building entrance terminals to the rack mounted voice patch panels utilizing plenum rated high pair count cable.

c) The Contractor shall furnish and install:

(1) 48 Port Patch Panel(s) as indicated on the technology drawings.

(2) 24 Port Patch Panel(s) as indicated on the technology drawings.

C. Horizontal Cable

1. No horizontal cable shall be longer than two hundred ninety-five (295) feet. If any station cable will be longer than two hundred ninety-five (295) feet, Contractor shall stop installation of the cable and immediately notify Architect/Engineer in writing. If Contractor fails to notify the Architect/Engineer in writing, Contractor shall replace cable at no cost to the Owner.

2. The Contractor shall furnish and install horizontal cables within each Technology Region from the respective ER or TR to each outlet location as indicated in the technology drawings.

3. The Contractor shall install a 10-foot service loop to be coiled, mounted, and stored above the ladder rack in each respective Equipment Room or Telecommunications Room.

4. The Contractor shall provide a 4 feet to 5 feet of slack built into the path of the cable run to be used as service loop. No loops are to be placed/coiled above ceiling at the work station outlet.

5. The contractor shall terminate horizontal cable to nearest telecommunications room. Locations on drawings are representative in nature.

D. Horizontal Cable Termination

1. Contractor shall terminate cables as defined by the ANSI/TIA/EIA 568-A Commercial Building Wiring Standard with the EIA-568B sequence.

2. Workstations

a. Contractor shall furnish and install modular jacks to terminate UTP horizontal cables.

b. Contractor shall furnish and install faceplates, systems furniture faceplates, or surface-mount boxes to house modular jacks as indicated in the technology drawings.

1) Any unused faceplate positions shall have the appropriate number and color of blanks installed.

3. Equipment Rooms / Telecommunications Rooms

a. Horizontal Cable for Data

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal data cables as indicated in the technology drawings.

2) The Contractor shall provide and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

b. Horizontal Cable for Voice

1) The Contractor shall furnish and install 110-type blocks to terminate horizontal voice cables.

2) 110-type blocks shall be equipped with legs, cable management, label holders, labels, and C4 clips.

3) The Contractor shall furnish and install:

a) 110-type block(s) in IDF Room as indicated on the technology drawings.

c. Horizontal Cable for IP Security

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal IP security cables as indicated in the technology drawings.

2) The Contractor shall provide and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

d. Horizontal Cable for Wireless Access Points

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal wireless access point cables as indicated in the technology drawings.

2) The Contractor shall furnish and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

e. Horizontal Cable for Audio Visual

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal audio visual cables as indicated in the technology drawings.

2) The Contractor shall furnish and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

E. Horizontal Cable Routing in Telecommunications Rooms.

1) When running the Category 6 cable into the telecommunications rooms the Contractor shall **"NOT"** take the shortest path to the rack. The contractor is to take the longest path around the ladder rack to allow for additional service loop and slack.

2) The contractor is to verify the path with the owner prior to category 6 cable trim-out and termination.

F. Patch Cables

1. Fiber

a. Equipment Rooms / Telecommunications Room

1) The Contractor shall furnish and store (48) patch cables in original manufacturer packaging:

a) 100% of the patch cables shall be (2) meters in length and stored in new IDF room.

b) Contractor shall verify quantities and lengths with the architect and owner prior to purchase.

2. Copper

a. Workstations

1) The Contractor shall furnish and install (1) patch cable in original manufacturer packaging for each cable terminated including above ceiling outlets.

a) 90% of the patch cables shall be (10) feet in length and 30% of the patch cables shall be (25) feet in length and stored in the applicable Equipment Room / Telecommunications Room.

b. Equipment Rooms / Telecommunications Rooms

1) The Contractor shall furnish and store (1) patch cable in original manufacturer packaging for each cable terminated per Equipment Room / Telecommunications Room:

a) 70% of the patch cables shall be (7) foot in length and 30% of the patch cables shall be (10) feet in length and stored in the applicable Equipment Room / Telecommunications Room

G. Cable Support

1. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.

2. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or adjustable cable supports.

3. No cable pathway shall exceed 40% fill ratio.

4. The contractor shall furnish a separate j-hook or adjustable cable support pathway for each cable type (data, voice, video, and security).

5. J-hooks and adjustable cable supports shall be installed no more than five-feet (5') apart on center, using only manufacturer-approved installation methods and hardware.

6. J-hooks and adjustable cable supports shall be installed no higher than 3-feet above the accessible ceiling to allow for ease of access for future moves, adds and changes

7. The contractor shall not utilize the ceiling grid wire for J-hooks.

8. J-hooks shall be furnished with closure clips.

9. Maximum sag between supports shall not exceed twelve-inches (12").

10. Contractor shall establish j-hook and adjustable cable supports pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.

11. Cable Dressing

    a. No nylon cable ties shall be used at any time during the installation of the cable.

    b. Above Ceiling

        1) Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.

            a) The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.

    c. Equipment Rooms / Telecommunications Rooms

        1) The Contractor shall bundle all visible cables with Contractor furnished and installed hook & loop straps.

            a) Hook & loop straps shall be installed twenty-four (24) inches apart on center.

H. Equipment Rooms / Telecommunications Room Build-Out

1. Plywood

    a. The Contractor shall furnish and install 8' H x 4' W x ¾" D sheets of BC grade fire-rated plywood as indicated in the technology drawings.

    b. The Contractor shall mount all plywood vertically starting at 24" AFF.

    c. The Contractor shall cover the plywood with two (2) coats of Contractor furnished white fire retardant paint leaving exposed (1) fire rating stamp per sheet.

2. Cable Runway (Ladder Type)

a. Contractor shall furnish and install cable runway using manufacturer-approved hardware and installation methods as indicated in the technology drawings.

b. Contractor shall furnish and install vertical sections of cable runway using manufacturer-approved hardware and installation methods to provide transition and support where cables enter or exit the room using a vertical pathway.

c. Contractor shall furnish and install radius drops cross member and stringers above each rack using manufacturer-approved hardware and installation methods where cables exit the horizontal section of the ladder rack.

d. Contractor shall ground and bond each cable runway section to the next utilizing ground straps and ensure metal-to-metal contact.

3. Equipment Racks and Cabinets

a. Contractor shall furnish and install equipment racks with vertical management using manufacturer approved hardware and installation methods as indicated in the technology drawings.

b. Contractor shall secure relay racks to the concrete floor utilizing expandable concrete anchors.

c. Contractor shall secure the equipment racks to the cable runway using cable runway elevation kits and manufacturer approved hardware and installation methods.

d. Contractor shall bolt all equipment racks and vertical cable managers together.

e. Contractor shall individually ground and bond each equipment rack and ensure metal-to-metal contact.

f. Contractor shall furnish and install:

1) 19” x 84" equipment rack(s) in new IDF Room as indicated on the technology drawings

I. System Labeling

1. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.

2. Horizontal Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications Rooms.

3. Horizontal Cables shall be labeled within (6) inches from the termination point at the workstation end.

4. Backbone Fiber and Copper Cables shall be labeled within (12) inches of the visible end of the jacket.

5. Fiber Innerduct shall be labeled within (12) inches of the point of entry of the fiber optic enclosure.

6. Bonding conductors shall be labeled within (12) inches from their termination point.

7. Cables shall be labeled identically at both ends.

8. Equipment Racks

   a. Equipment racks in each Equipment/Telecommunication Room shall be labeled in sequential numeric order.

      1) Labels shall be centered on the top front of the equipment rack.

9. Horizontal Cable

   a. Inside Equipment Rooms

      1) Horizontal cables shall be labeled at each end with the destination end and origin room number, patch panel number, and port number. (i.e. XXX-1.D1-A01).

      2) Patch panels in each closet shall be labeled sequentially starting with the first Patch Panel in the top of the first relay rack (A, B, C, D, E, etc.).

      3) 110-type blocks shall contain the destination room number, pair numbers, and binder pair number under each pair termination. (example)

         a) 110-type block labels shall be printed on product-specific label strips and placed into label holders.

      4) All labeling shall be verified with the owner prior to labeling. If the contractor does not get written approval prior to labeling and the labeling is incorrect, the labeling will be corrected at the contractors expense.

10. Workstation Faceplates

    a. Cables and wall plates shall be labeled denoting origin, Equipment Room/Telecommunications Room Number, Patch Panel, 110-type termination block, and Port Number. (i.e. 1.D1-A01).

    b. Each Room labeling sequence shall be clockwise.

    c. All labeling shall be verified with the owner prior to labeling. If the contractor does not get written approval prior to labeling and the labeling is incorrect, the labeling will be corrected at the contractors expense.

11. TMGB and TGB

    a. TMGB and TGB shall be labeled with a unique identifier (i.e. TMGB-XXX, TGB-1.D1).

12. Bonding Conductors

    a. The following conductors shall be labeled at each end with the destination end and origin room number (i.e. XXX – IDF1.D1).

       1) Bonding Conductor for Telecommunications

2) Telecommunications Bonding Backbone

3) Grounding Equalizer

3.05 Testing Requirements

A. Fiber Optic Cable

1. Installed strands shall be tested and certified in accordance with industry standards.

2. Only Manufacturer Certified Technicians shall perform testing.

3. The Contractor shall test and certify all fiber optic cable strands with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.

4. The Contractor shall provide calibration results from the manufacturer showing the current calibration of the testers.

5. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe cable testing.

6. The Architect/Engineer may randomly select 5% of the installed strands for test verification purposes. The Contractor shall re-test these strands in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed strands at no cost to the Owner.

B. Copper Backbone Cable

1. Installed pairs shall be tested and certified in accordance with industry standards.

2. Only Manufacturer Certified Technicians shall perform testing.

3. The Contractor shall test and certify all copper pairs with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.

4. The Contractor shall provide calibration results from the manufacturer showing the current calibration of the testers.

5. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe cable testing.

6. The Architect/Engineer may randomly select 5% of the installed pairs for test verification purposes. The Contractor shall re-test these pairs in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed pairs at no cost to the Owner.

C. Category 6 UTP Cable

1. Cable links shall be tested in accordance with industry standards.

2. Only Manufacturer Certified Technicians shall perform testing.

3. The Contractor shall test and certify the structured cable system with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.

4. No Fail or *Pass results will be accepted.

5. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe field testing.

6. The Architect/Engineer may randomly select 5% of the installed links for test verification purposes. The Contractor shall re-test these links in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously-submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed links at no cost to the Owner.

D. Grounding and Bonding

1. Main Building Ground

a. Coordinate with electrical contractor and provide a copy of their test results for the main building ground. The results shall be below 10 Ohms.

2. Two-Point Ground/Continuity Testing

a. Prior to the two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the drawings and specifications and in compliance with the TIA-607-B Standard.

b. All testing shall be conducted prior to any active equipment is installed.

c. The Contractor shall use an earth ground resistance tester that is configured for a continuity test. This is also known as a two-point tester or a “dead earth” test.

d. Prior to the two-point continuity test conduct a voltage test to ensure there is no stray voltage in the system.

e. The testing shall include but is not limited to the following points.

1) Building electrical grounding electrode and the TMGB.

2) TMGB/TGB to electrical ground in ER/TR.

3) TMGB/TGB to the building steel (if present).

4) TMGB to each TGB.

5) Building steel (if present) to the electrical ground.

f. Per the TIA-607-B, the maximum value for resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system is 100 milliohms. In the case of long TBB and Grounding Equalizer conductor runs, the resistance of the conductor must be factored into the total resistance. For example 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft.)

g. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe field testing.

3.06 Project Closeout Documentation

A. As-Built Drawings

1. Drawings shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect/Engineer.

2. Three (3) sets of drawings depicting the condition of the structured cabling system as installed.

3. As-Built drawings shall be produced in AutoCAD 2014 or higher and provided in hardcopy and electronically in .dwg and PDF format.

4. Hardcopy drawings shall be provided in the original size as issued by the Architect/Engineer.

5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Engineer.

6. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of all equipment room/telecommunication room layouts, wall elevations, equipment rack elevations, ladder racks, cable tray, sleeves, backbone and horizontal cable pathways, workstation locations, and labeling scheme.

B. Test Documentation

1. Test documentation shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until these test results are received and approved by the Architect/Engineer.

2. Three (3) sets of test documentation for the structured cabling system as installed.

3. Test results shall be provided in hard copy and electronic format (i.e., manufacturer's proprietary testing software along with applicable reader software) and PDF electronic format.

4. Test documentation shall be bound, sectioned, and tabbed in the following sequence as applicable:

a. Tester(s) Calibration Certificate(s)

b. Inter-Building Backbone Fiber Optic Cable

c. Inter-Building Backbone Copper Cable

d. Intra-Building Backbone Fiber Optic Cable

e. Intra-Building Backbone Count Copper

f. Horizontal Category 3 Cable

g. Horizontal Category 5e Cable

h. Horizontal Category 6 Cable

i. Horizontal Category 6A Cable

j. Main Building Ground

k. Two-Point Ground/Continuity Test

C. Manufacturer's Performance Certification

1. Certificate shall be provided to the Architect/Engineer at the time of final system acceptance. Final payment will not be recommended until the certificate of certification is received and approved by the Architect/Engineer.

   a. The manufacturer of the solution shall furnish a performance certification for a period of no less than twenty (20) years starting at final system acceptance.

   b. One original and two copies of the Manufacturer's Certificate shall be provided.

D. Manufacturer's Product Warranty

1. Certificate of product warranty shall be provided to the Architect/Engineer at the time of final system acceptance. Final payment will not be recommended until this certificate of product warranty is received and approved by the Architect/Engineer.

   a. The manufacturer of the solution shall furnish an extended warranty for a period of no less than twenty (20) years starting at final system acceptance.

   b. One original and two copies of the Manufacturer's product warranty shall be provided.

E. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Engineer.

   a. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.

   b. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

END OF SECTION 27 10 00

SECTION 27 10 00 - STRUCTURED CABLING SYSTEM

CAT 6A ALTERNATE #2

PART 1 - GENERAL

1.01 This section identifies the requirements, technical design, and specifications for the structured cabling system at the University of Texas Rio Grande Valley, located in Edinburgh, Texas ("Owner"). The structured cabling system as specified is an Industry-Standard Category 6A structured cabling system and includes backbone cabling, horizontal cabling and equipment room hardware as specified.

1.02 The Contractor shall provide a Manufacturer's 20-Year Performance Certification for the installed structured cabling system.

1.03 Contractor shall include materials, equipment, and labor necessary to provide a complete and functional structured cabling system regardless of any items not listed or described in this specification or associated drawings.

1.04 Requirements

A. Contractor Experience Requirements

B. Submittal Requirements

C. Acceptable Manufacturers

D. Codes, Standards and Regulations

E. General Requirements

F. System Requirements

G. Testing Requirements

H. Project Closeout Documentation

I. Attachments

1.05 Related Requirements

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 27, and shall be complied with in every respect. The Contractor shall examine all of the items which make up the Contract Documents, and shall coordinate them with the work on the project.

B. Contractor Experience Requirements

1. The Contractor shall be a Leviton Premier Partner prior to submitting a bid for the work.

2. The Contractor shall possess all relevant Manufacturer Certifications (i.e. structured cable systems, testing equipment, etc,) for both the company and individual technicians prior to submitting a bid for the work.

3. The Contractor's Project Manager shall be a Registered Communications Distribution Designer (RCDD) and available for all onsite coordination meetings.

4. The Contractor shall have been in business for a minimum of five (5) years.

5. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

6. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

C. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.06 Submittal Requirements

A. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect/Engineer.

2. All submittals shall be submitted in the same sequence as they are listed in the specifications (i.e. product data in the sequence items are listed in the product data section, manufacturer product certifications for company, manufacturer product certifications for installers, etc.). Submittals not in the proper sequence will not be approved.

3. Manufacturer product data sheets for each proposed system component.

   a. For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted. Product data sheets without the part number clearly identified will not be approved.

4. Manufacturer Product Certifications for Company.

5. Manufacturer Product Certifications for Installers.

6. Manufacturer Certifications for testing equipment technicians.

7. Manufacturer Certifications for testing equipment calibration.

8. RCDD Certificate for Contractor's Project Manager.

9. Manufacturer Warranty letter.

10. Documentation indicating that Contractor has been in business for (5) years.

11. Address of Contractor's local office within a 75-mile radius of the project site.

12. Quantity of full time local technicians within a 75-mile radius of the project site.

13. List of five (5) contractor-installed projects of a similar size and scope that have been in operation for at least (1) year. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

14. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.

15. List of subcontractors performing any work on the project. List shall clearly identify the subcontractor's legal name and address, the scope of work to be performed by the subcontractors and the overall percentage of the project being provided by the subcontractor. If there are no subcontractors performing any work on the project, submit a statement on company letterhead clearly indicating no subcontractors will be performing any work on this project.

PART 2 - PRODUCTS

2.01 General Requirements

A. The following sections specifically list the acceptable equipment types and items for this project.

B. Architect/Engineer will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

C. Proposed equivalent items must be approved in writing by the Architect/Engineer prior to purchase or installation. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

D. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall substitute the appropriate equivalent manufacturer's part number.

E. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished.

F. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.

G. All wiring, equipment, and installation materials shall be new and of the highest quality.

H. Labels on all cabling, materials, and equipment must indicate a nationally recognized testing laboratory.

I. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer which certifies performance characteristics and compliance with ANSI/TIA/EIA 568-C standards.

2.02 Acceptable Manufacturers

A. Fiber Optic Backbone Cable

1. Indoor

a. 9/125µm Single-Mode Plenum Rated 12 Strand Armored

1) Superior Essex Part Number – L40123401

2) Commscope Equivalent with Panduit Solution.

2. Outdoor Underground

a. 9/125µm Indoor/Outdoor Single-Mode 24 Strand Armored

3. OSP Allwave ZWP Singlemode Fiber – Part Number AT-3BE12YT-024

4. Fiber Optic Inner-duct

a. Outdoor (Maxcell)

1) MaxCell 2" 3-Cell, Detectable – 1000 feet spool – Part Number – MXD2003XX1000

2) Carlon Plenum Rated 1-inch Orange Corrugated Inner-duct. Part Number - CF4X1C-5200 (or equivalent)

B. Copper Backbone Cable

1. Indoor

a. Category 3 24 AWG Unshielded Twisted Pair (UTP) Plenum (Gray Sheath)

1) Superior Essex Part Number – 25-Pair – 18-475-36

2) Panduit Equivalent with Panduit Solution.

b. Category 3 24 AWG Unshielded Twisted Pair (UTP) Riser Rated (Gray Sheath)

1) Superior Essex Part Number – 25-Pair – 18-475-33

2) Panduit Equivalent with Panduit Solution.

2. Outdoor Underground

a. Category 3 22 AWG Unshielded Twisted Pair (UTP) Indoor/Outdoor

1) Superior Essex Part Number – 25-Pair – PE 89, 20-062-05

2) Panduit Equivalent with Panduit Solution.

C. Horizontal Cable

1. Category 6A UTP Plenum

a. Network Access (Blue Sheath)

1) Berk-Tek LANmark- 10G2 Part Number – 11085339

2) Panduit Equivalent with Panduit Solution.

b. Wireless Access Points (Orange Sheath)

1) Berk-Tek LANmark-10G2 Part Number – 10138767

2) Panduit Equivalent with Panduit Solution.

c. Security Access (Green Sheath)

1) Bertek Lanmark-10G2 Part Number – 11085826

2) Panduit Equivalent with Panduit Solution.

d. Category 6A UTP Flooded

1) Superior Essex OSP-6 UTP Part Number – 04-001-A4

2) Panduit Equivalent with Panduit Solution.

D. Copper Cable Termination

1. Category 6A Horizontal Rack Mounted Patch Panels

a. Leviton 1RU 24-Port QuickPort Flat Panel (modular) – Part Number 49255-H24

b. Leviton 2RU 48-Port QuickPort Flat Panel (modular) – Part Number 49255-H48

c. Contractor shall provide jacks to support the modular patch panels. All unused patch panel ports shall be populated to the owner future use.

d. Panduit Equivalent

2. Category 6A Modular Jacks

a. Network Access

1) Equipment Room/Telecommunications Room End (Black)

a) Leviton QuickPort eXtreme 10G CAT 6A Connector – Part Number 6110G-RE6.

b) Field End (yellow)

Leviton QuickPort eXtreme 10G CAT 6A Connector – Part Number 6110G-RY6.

c) Wireless Access Equipment/Telecommunications Room and Field end (Orange)

Leviton QuickPort eXtreme 10G Cat 6A Connector – Part Number 6110G-OR6.

d) Security Access Equipment/Telecommunications Room (Green)

Leviton QuickPort eXtreme 10G Cat 6A Connector – Part Number 6110G-GR6.

e) Panduit Mini Com Equivalent

E. Fiber Optic Cable Termination

1. 2RU Fiber Enclosure
   a. Leviton Rack Mounted Fiber Optic Enclosure – Part Number 5R2UH-S06
   b. Panduit Equivalent
2. 9µm Single-Mode Fiber Adapter Plate
   a. Leviton SC/UPC Single-mode 12 fibers, Part Number – FT-DSCAPC6LBLK
   b. Panduit Equivalent
3. Fiber Blank Plate
   a. Blank Adapter Plate – Part Number 5F100-BLK
   b. Panduit Equivalent
4. 9µm Single-Mode SC/UPC Pigtails
   a. Leviton SC/UPC Fiber Pigtails - Part Number UPPSC-S03
   b. Leviton 12 Fiber Splice Trays – Part Number T5PLS-12F
   c. Panduit Equivalent
5. Loose Tube Fiber Fan-Out Kit
   a. Corning Fiber Optic Fan-Out Kit, 12-fiber – Part Number – FAN-BT25-12
6. Fiber Optic Splice Case
   a. Coyote 6.5-inch x 22-inch Dome Splice Case with (3) LGSTS72 Splice Trays- Part Number – 8006877

F. Copper Cable Termination

1. Building Entrance Terminals
   a. Primary Copper Protectors
      1) Circa 50-Pair 110 Style Lightning Protection Block – Part Number – 1880ENA1/NSC-50GT1.
      2) Circa 240 volt Solid State Module with PTC – Part Number – 4B1FS-240
2. Backbone Cable Termination Panels
   a. Rack Mounted Voice Patch Panels

1) Leviton Cat 5e 24-Port Flat 110-Style Patch Panel – Part Number 5G596-U24.

b. Termination Block Kit Components

1) Leviton Cat 6 110-Style Wiring Block, Wall Mount w/ Legs, CAT 6, 50-Pair – Part Number – 41AW1-050

2) Leviton Horizontal Cable Management Trough Part Number – 41CMS-HCM

3) Panduit Equivalent

3. Telecommunications Faceplates with Designation Window

a. 2-Port Single Gang Flush (White)

1) Leviton Plastic Wallplate with ID Window – Part Number 42080-2WS

b. 4-Port Single Gang Flush (White)

1) Leviton Plastic Wallplate with ID Window – Part Number 42080-4*S

c. 8-Port Double Gang Flush (White)

1) Leviton Plastic Wallplate with ID Window – Part Number 42080-8WP

d. Wall Phone Faceplate (Stainless Steel)

1) Leviton Stainless Steel Wall Phone Plate (Recessed) – Part Number 4108W-1SP

e. Panduit Mini Com Equivalent

4. 2-Port Surface Mount Box (White)

a. Leviton Surface Mount Box – Part Number 41089-2WP

b. Panduit Mini Com Equivalent

5. 4-Port Surface Mount Box (White)

a. Leviton 4 Port Surface Mount Box – Part Number 41089-4xP

b. Panduit Mini Com Equivalent

6. Blank Insert (White) (Package of 10)

a. Leviton Blank Insert – Part Number 41084-BWB

b. Panduit Mini Com Equivalent

7. 2-Port Surface Mount Box (White)

a. Leviton QuickPort Surface Mount Box – Part Number 41089-2WP

b. Panduit Mini Com Equivalent

8. Blank Insert (White)
    a. Leviton QuickPort Blank Insert – Part Number 41084-BWB
    b. Panduit Mini Com Equivalent

G. Equipment Racks, Cabinets, Cable Management, and Accessories
1. Two-Post Rack - 19” x 84” Open Frame (Black)
    a. Chatsworth – Part Number 48353-703
2. Vertical Cable Managers (Black)
    a. Chatsworth Double Sided Vertical cabling Section - Part Number 30095-703
3. Horizontal Cable Managers (Black)
    a. Chatsworth Rack Cabling Manager - Part Number 30130-719
4. Horizontal Wire Troughs
    a. Chatsworth Wire Trough – Part Number CMUT19
5. Vertical Metered Power Strip for 7’ Equipment Rack
    a. Chatsworth Vertical Power Strip with Meter and NEMA input L6-20P Locking Plug and output (24) C13, (6) C19 (24) 5-20P - Part Number Part Number – L2-1E0E3.
    b. a. Contractor shall install (1) vertical power strip in each equipment rack.

H. Cable Runway (Ladder Type)
1. Universal Cable Runway
    a. 18-inch Chatsworth - Part Number 10250-718
2. Cable Runway Radius Drop, Cross Member
    a. 18-inch Chatsworth - Part Number 12100-718
3. Cable Runway Radius Drop, Stringer
    a. Chatsworth - Part Number 12101-701
4. Cable Runway Butt-Splice Kit
    a. Chatsworth - Part Number 11301-701
5. Cable Runway Junction-Splice Kit
    a. Chatsworth - Part Number 11302-701
6. Cable Runway Butt-Swivel Splice Kit
    a. Chatsworth - Part Number 10487-701

7. Rack-to-Runway Mounting Kit
    a. 15 to 18-inch runway Chatsworth - Part Number 10595-718
8. Cable Runway Elevation Kit for Racks
    a. Chatsworth - Part Number 10506-706
9. Triangular Support Bracket, Aluminum
    a. 12 to 18-inch runway Chatsworth - Part Number 11421-718
10. Wall Angle Support Kit, Cable Runway
    a. 18-inch runway Chatsworth - Part Number 11421-718
11. 90 Degree Runway-Splice Kit
    a. Chatsworth - Part Number 11314-701
12. 45 Degree Runway-Splice Kit
    a. Chatsworth - Part Number 11313-712
13. Foot Kit, Cable Runway
    a. Chatsworth - Part Number 11309-001
14. Vertical Wall Brackets (pair)
    a. Chatsworth - Part Number 10608-701
15. Threaded Ceiling Kit, Cable Runway
    a. Chatsworth - Part Number 11310-001
16. Threaded Rod Cover
    a. Chatsworth - Part Number 11085-001
17. Protective End Caps for Cable Runway
    a. Chatsworth - Part Number 10642-001
18. End Closing Kit, Cable Runway
    a. Chatsworth - Part Number 11700-712

I. Pathway Cable Support
    1. Panduit J-Mod Cable Support System
    2. Erico – CADDY CAT LINKS J-Hook Series
    3. Erico – Caddy Adjustable Cable Support Series
    4. Panduit Plenum Rated Hook & Loop (Black)
    5. Erico – Caddy Grid Support – Part Number – ATA41 or ATS41

J. Grounding and Bonding

1. Grounding Bus Bar, 20”
   a. Chatsworth - Part Number 40153-020
2. Grounding Bus Bar, 12”
   a. Chatsworth - Part Number 13622-012
3. Cable Runway Ground Strap Kit
   a. Chatsworth - Part Number 40164-001
4. One Mounting Hole Ground Terminal Block
   a. Chatsworth - Part Number 08009-001
5. Two Hole Compression Ground Lug
   a. Chatsworth – Part Number 40162-901
6. #6 AWG Solid Green Insulation Ground Wire
   a. Superior Essex - Part Number 12-018-04
7. #3/0 Stranded Green Insulation Ground Wire
8. Cable Sheath Bonding Clamp

K. Labeling

1. Permanent Labels for Fiber Optic Cables
   a. Brady
   b. Panduit Self Laminating Labels
2. Permanent Labels for Innerduct
   a. Panduit Dome-Top Ty Marker
3. Permanent Labels for Copper Cables
   a. Panduit Self-Laminating Labels
4. Permanent Labels for Backbone Fiber Optic Cables
   a. Panduit Dome-Top Ty Marker
5. Permanent Labels for Patch Panels
   a. Panduit Component Label
6. Permanent Labels for Faceplates
   a. Panduit Component Label

L. Fire Stop

1. STI Spec Seal Part Number
2. 3M Products Part Number

M. Copper Patch Cables

1. Leviton eXtreme Category 6+ SlimLine UTP Patch Cord – Part Number 6AS110-XXX*. Verify Quantities and lengths with owner prior to purchase.
2. 6ft copper patch cables for IDF room
3. 10ft copper patch cables for work stations.
4. Panduit Equivalent.

N. Fiber Optic Patch Cables

1. Leviton SC-SC UPC 1 Meter Fiber Optic Patch Cord Part Number - APSSC-S01
2. Leviton SC-SC UPC 2 Meter Fiber Optic Patch Cord Part Number - APSSC-S02
3. Leviton SC-SC UPC 3 Meter Fiber Optic Patch Cord Part Number - APSSC-S03
4. Leviton multimode 50 micron SC-LC UPC 3 Meter Fiber Optic Patch Cord Part Number – 50-D-CL-M03
5. Leviton singlemode SC-LC UPC 3 Meter Fiber Optic Patch Cord Part Number – AP-S-CL-S03
6. Panduit Equivalent

PART 3 - EXECUTION

3.01 Codes, Standards, Regulations

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)

1. Telecommunications Distribution Methods Manual 13th Edition

2. Outside Plant Design Reference Manual 5th Edition

3. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices

4. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling

5. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Electronics Industry Alliance (EIA)

F. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998

2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998

3. FCC Part 76, Cable Television Service, revised 1998

G. Insulated Cable Engineers Association (ICEA)

1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable

2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors

3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

H. International Electrotechnical Commission (IEC)

I. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System

2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive

3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)

4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code

5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

J. International Organization for Standardization (ISO)

1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)

2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

3. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

4. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

5. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

K. National Cable Television Association (NCTA)

L. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits.

M. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code

2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.

3. NFPA-101, Life Safety Code

4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems

5. NFPA-780, Standard for the Installation of Lightning Protection Systems.

N. National Institute Standards and Technology (NIST)

O. Occupational Safety and Health Administration (OSHA)

P. Telecommunications Industry Association (TIA)

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009

2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009

3. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, 2009

4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2008

5. ANSI/TIA/EIA–569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005

6. ANSI/TIA–569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009

7. ANSI/TIA/EIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012

8. ANSI/TIA/EIA-607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications, 2011

9. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004

Q. U.S. Department of Agriculture (USDA)

1. RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction

2. RUS Bull 1751F-643 (2002) Underground Plant Design

3. RUS Bull 1751F-815 (1979) Electrical Protection of Outside Plant

4. RUS Bull 1753F-201 (1997) Acceptance Tests of Telecommunications Plant (PC-4)

5. RUS Bull 1753F-401 (1995) Splicing Copper and Fiber Optic Cables (PC-2).

6. RUS Bull 345-65 (1985) Shield Bonding Connectors (PE-65)

7. RUS Bull 345-72 (1985) Filled Splice Closures (PE-74)

8. RUS Bull 345-83 (1979; Rev Oct 1982) Gas Tube Surge Arrestors (PE-80)

R. Underwriters Laboratories, Inc. (UL)

1. UL 510 (2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

2. UL 910 (NFPA 262 1990) Applicable Flame Test

3.02 In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify the Architect/Engineer in writing of any such occurrences before purchasing or installing any equipment or materials. The Architect/Engineer will notify the Contractor of any actions required to resolve these

conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications. In the event of any conflicts between Standards and Codes the more stringent shall take precedence.

3.03 General Requirements

A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect/Engineer for direction before proceeding with that part of the work.

B. The Contractor shall be responsible for coordination with other trades to ensure any conflicts or potential conflicts are resolved prior to any work beginning on the project.

C. The Contractor shall install the materials in accordance with these specifications and the manufacturer’s installation guidelines.

D. No deviations from the plans or specifications shall be made without full consent in writing of the Architect/Engineer. The Contractor shall have written approval from the Architect/Engineer for any additional work beyond the Contract Documents prior to beginning such work. If the Contractor does not obtain written approval from the Architect/Engineer prior to proceeding with the work, the contractor shall not be reimbursed for the work.

E. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, walls, roofs, or ceilings.

F. Contractor shall notify the Architect/Engineer a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect/Engineer to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

G. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap cable, etc., and dispose of such items on a daily basis and return the site to the original

state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

H. Equipment and materials installed by the Contractor shall be free of defects and damage.

I. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

J. Contractor shall test all cables prior to installation. By failing to perform this testing operation, the Contractor shall accept the cable as compliant and assume all liability for the replacement of the cable at no cost to the Owner should it be found defective at a later date.

K. Contractor shall maintain a set of working specifications, design drawings, and record drawings to be kept on site at all times and shall update the record drawings with any changes on a weekly basis. Record drawings shall be made available for inspection at the request of the Architect/Engineer.

L. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

M. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

N. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect/Engineer.

O. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

P. Cables shall be properly supported in accordance with industry standards at all times. Improperly supported cables shall be corrected by the Contractor at no cost to the Owner.

Q. Contractor shall be responsible to properly protect information outlets from damage by other trades during construction.

R. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

S. The Contractor shall not install cables in conduits or sleeves without nylon bushings. Cables installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

3.04 System Requirements

A. Quantities listed are for reference only, contractor is responsible for furnishing materials as required to provide a complete and functioning system. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity shall be furnished.

B. Inter-Building Cable Plant

1. Fiber Optic Cable

a. 9 µm Single Mode

1) Contractor shall furnish and install outdoor underground armored fiber optic cables in contractor-furnished and installed Maxcell inner-duct.

a) Each armored fiber optic cable shall be provided installed inside the Maxcell Inner-Duct with a jetline installed with the cable.

2) The Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.

3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.

4) The contractor shall furnish and install:

a) 24 strand outdoor armored fiber optic cable from New IDF Room to the SOM MDF room as indicated on the technology drawings.

b) 24 strand outdoor armored fiber optic cable from New IDF Room to the Splice point located inside the Chase Near the Academic Services Building as indicated on the technology drawings.

c) Provide and install 2- inch 3 cell maxcell as directed in the technology drawings

2. Fiber Optic Termination

a. Contractor shall Fusion Splice the new armored fiber optic strands with fan-out kits as required and place into fiber optic splice cases with splice trays as indicated in the technology drawings.

b. Contractor shall furnish fiber optic enclosures and coupler panels for all fiber optic strands and blank panels for all unused slots.

c. The Contractor shall furnish and install:

1) 2RU fiber enclosure(s) inside new IDF Room as indicated on the technology drawings.

2) 2RU fiber enclosure(s) inside the SOM MDF as indicated on the technology drawings.

3. Copper Cable

a. High Pair Count Cable

1) Contractor shall furnish and install outdoor underground copper cables.

2) The Contractor shall install a 10-foot service loop at the ends of each cable to be coiled, mounted, and stored on the wall above the ladder rack.

3) Cables shall be routed utilizing the pathways as indicated in the technology drawings.

4) The contractor shall furnish and install:

a) 25 pair armored copper cable(s) from new IDF Room to the existing SOM Room as indicated on the technology drawings.

b. High Pair Count Termination

1) Building Entrance Terminals

a) The contractor shall terminate all copper cable pairs on contractor furnished and installed building entrance terminals as indicated in the technology drawings.

b) Contractor shall furnish and install all terminals fully populated with surge protection modules.

c) Contractor shall ground and bond all cables and terminals.

d) The Contractor shall furnish and install:

(1) 25 Pair Category 5e Building Entrance Terminal(s) in new IDF Room as indicated on the technology drawings.

(2) 25 Pair category 5e Building Entrance Terminal(s) in existing MDF Room as indicated on the technology drawings.

2) Patch Panels

a) The Contractor shall furnish and install rack mounted voice patch panels.

b) The Contractor shall extend all copper cable pairs from the building entrance terminals to the rack mounted voice patch panels utilizing plenum rated high pair count cable.

c) The Contractor shall furnish and install:

(1) 48 Port Patch Panel(s) as indicated on the technology drawings.

(2) 24 Port Patch Panel(s) as indicated on the technology drawings.

C. Horizontal Cable

1. No horizontal cable shall be longer than two hundred ninety-five (295) feet. If any station cable will be longer than two hundred ninety-five (295) feet, Contractor shall stop installation of the cable and immediately notify Architect/Engineer in writing. If Contractor fails to notify the Architect/Engineer in writing, Contractor shall replace cable at no cost to the Owner.

2. The Contractor shall furnish and install horizontal cables within each Technology Region from the respective ER or TR to each outlet location as indicated in the technology drawings.

3. The Contractor shall install a 10-foot service loop to be coiled, mounted, and stored above the ladder rack in each respective Equipment Room or Telecommunications Room.

4. The Contractor shall provide a 4 feet to 5 feet of slack built into the path of the cable run to be used as service loop. No loops are to be placed/coiled above ceiling at the work station outlet.

5. The contractor shall terminate horizontal cable to nearest telecommunications room. Locations on drawings are representative in nature.

D. Horizontal Cable Termination

1. Contractor shall terminate cables as defined by the ANSI/TIA/EIA 568-A Commercial Building Wiring Standard with the EIA-568B sequence.

2. Workstations

a. Contractor shall furnish and install modular jacks to terminate UTP horizontal cables.

b. Contractor shall furnish and install faceplates, systems furniture faceplates, or surface-mount boxes to house modular jacks as indicated in the technology drawings.

1) Any unused faceplate positions shall have the appropriate number and color of blanks installed.

3. Equipment Rooms / Telecommunications Rooms

a. Horizontal Cable for Data

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal data cables as indicated in the technology drawings.

2) The Contractor shall provide and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

b. Horizontal Cable for Voice

1) The Contractor shall furnish and install 110-type blocks to terminate horizontal voice cables.

2) 110-type blocks shall be equipped with legs, cable management, label holders, labels, and C4 clips.

3) The Contractor shall furnish and install:

a) 110-type block(s) in IDF Room as indicated on the technology drawings.

c. Horizontal Cable for IP Security

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal IP security cables as indicated in the technology drawings.

2) The Contractor shall provide and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

d. Horizontal Cable for Wireless Access Points

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal wireless access point cables as indicated in the technology drawings.

2) The Contractor shall furnish and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

e. Horizontal Cable for Audio Visual

1) Contractor shall furnish and install patch panels and horizontal cable managers to terminate horizontal audio visual cables as indicated in the technology drawings.

2) The Contractor shall furnish and install:

a) 48-port rack mounted patch panel(s) in new IDF Room as indicated on the technology drawings.

E. Horizontal Cable Routing in Telecommunications Rooms.

1) When running the Category 6 cable into the telecommunications rooms the Contractor shall **"NOT"** take the shortest path to the rack. The contractor is to take the longest path around the ladder rack to allow for additional service loop and slack.

2) The contractor is to verify the path with the owner prior to category 6 cable trim-out and termination.

F. Patch Cables

1. Fiber

a. Equipment Rooms / Telecommunications Room

1) The Contractor shall furnish and store (48) patch cables in original manufacturer packaging:

a) 100% of the patch cables shall be (2) meters in length and stored in new IDF room.

b) Contractor shall verify quantities and lengths with the architect and owner prior to purchase.

2. Copper

a. Workstations

1) The Contractor shall furnish and install (1) patch cable in original manufacturer packaging for each cable terminated including above ceiling outlets.

a) 90% of the patch cables shall be (10) feet in length and 10% of the patch cables shall be 25 feet in length and stored in the applicable Equipment Room / Telecommunications Room.

b. Equipment Rooms / Telecommunications Rooms

1) The Contractor shall furnish and store (1) patch cable in original manufacturer packaging for each cable terminated per Equipment Room / Telecommunications Room:

a) 70% of the patch cables shall be (7) foot in length and 30% of the patch cables shall be (10) feet in length and stored in the applicable Equipment Room / Telecommunications Room

G. Cable Support

1. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.

2. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or adjustable cable supports.

3. No cable pathway shall exceed 40% fill ratio.

4. The contractor shall furnish a separate j-hook or adjustable cable support pathway for each cable type (data, voice, video, and security).

5. J-hooks and adjustable cable supports shall be installed no more than five-feet (5') apart on center, using only manufacturer-approved installation methods and hardware.

6. J-hooks and adjustable cable supports shall be installed no higher than 3-feet above the accessible ceiling to allow for ease of access for future moves, adds and changes

7. Contractor shall not utilize ceiling grid wire for J-hooks.

8. J-hooks shall be furnished with closure clips.

9. Maximum sag between supports shall not exceed twelve-inches (12").

10. Contractor shall establish j-hook and adjustable cable supports pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.

11. Cable Dressing

    a. No nylon cable ties shall be used at any time during the installation of the cable.

    b. Above Ceiling

        1) Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.

            a) The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.

    c. Equipment Rooms / Telecommunications Rooms

        1) The Contractor shall bundle all visible cables with Contractor furnished and installed hook & loop straps.

            a) Hook & loop straps shall be installed twenty-four (24) inches apart on center.

H. Equipment Rooms / Telecommunications Room Build-Out

1. Plywood

    a. The Contractor shall furnish and install 8' H x 4' W x ¾" D sheets of BC grade fire-rated plywood as indicated in the technology drawings.

    b. The Contractor shall mount all plywood vertically starting at 24" AFF.

    c. The Contractor shall cover the plywood with two (2) coats of Contractor furnished white fire retardant paint leaving exposed (1) fire rating stamp per sheet.

2. Cable Runway (Ladder Type)

a. Contractor shall furnish and install cable runway using manufacturer-approved hardware and installation methods as indicated in the technology drawings.

b. Contractor shall furnish and install vertical sections of cable runway using manufacturer-approved hardware and installation methods to provide transition and support where cables enter or exit the room using a vertical pathway.

c. Contractor shall furnish and install radius drops cross member and stringers above each rack using manufacturer-approved hardware and installation methods where cables exit the horizontal section of the ladder rack.

d. Contractor shall ground and bond each cable runway section to the next utilizing ground straps and ensure metal-to-metal contact.

3. Equipment Racks and Cabinets

a. Contractor shall furnish and install equipment racks with vertical management using manufacturer approved hardware and installation methods as indicated in the technology drawings.

b. Contractor shall secure relay racks to the concrete floor utilizing expandable concrete anchors.

c. Contractor shall secure the equipment racks to the cable runway using cable runway elevation kits and manufacturer approved hardware and installation methods.

d. Contractor shall bolt all equipment racks and vertical cable managers together.

e. Contractor shall individually ground and bond each equipment rack and ensure metal-to-metal contact.

f. Contractor shall furnish and install:

1) 19” x 84" equipment rack(s) in new IDF Room as indicated on the technology drawings

I. System Labeling

1. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.

2. Horizontal Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications Rooms.

3. Horizontal Cables shall be labeled within (6) inches from the termination point at the workstation end.

4. Backbone Fiber and Copper Cables shall be labeled within (12) inches of the visible end of the jacket.

5. Fiber Innerduct shall be labeled within (12) inches of the point of entry of the fiber optic enclosure.

6. Bonding conductors shall be labeled within (12) inches from their termination point.

7. Cables shall be labeled identically at both ends.

8. Equipment Racks

   a. Equipment racks in each Equipment/Telecommunication Room shall be labeled in sequential numeric order.

      1) Labels shall be centered on the top front of the equipment rack.

9. Horizontal Cable

   a. Inside Equipment Rooms

      1) Horizontal cables shall be labeled at each end with the destination end and origin room number, patch panel number, and port number. (i.e. XXX-1.D1-A01).

      2) Patch panels in each closet shall be labeled sequentially starting with the first Patch Panel in the top of the first relay rack (A, B, C, D, E, etc.).

      3) 110-type blocks shall contain the destination room number, pair numbers, and binder pair number under each pair termination. (example)

         a) 110-type block labels shall be printed on product-specific label strips and placed into label holders.

      4) All labeling shall be verified with the owner prior to labeling. If the contractor does not get written approval prior to labeling and the labeling is incorrect, the labeling will be corrected at the contractors expense.

10. Workstation Faceplates

    a. Cables and wall plates shall be labeled denoting origin, Equipment Room/Telecommunications Room Number, Patch Panel, 110-type termination block, and Port Number. (i.e. 1.D1-A01).

    b. Each Room labeling sequence shall be clockwise.

    c. All labeling shall be verified with the owner prior to labeling. If the contractor does not get written approval prior to labeling and the labeling is incorrect, the labeling will be corrected at the contractors expense.

11. TMGB and TGB

    a. TMGB and TGB shall be labeled with a unique identifier (i.e. TMGB-XXX, TGB-1.D1).

12. Bonding Conductors

    a. The following conductors shall be labeled at each end with the destination end and origin room number (i.e. XXX – IDF1.D1).

       1) Bonding Conductor for Telecommunications

2) Telecommunications Bonding Backbone

3) Grounding Equalizer

3.05 Testing Requirements

A. Fiber Optic Cable

1. Installed strands shall be tested and certified in accordance with industry standards.

2. Only Manufacturer Certified Technicians shall perform testing.

3. The Contractor shall test and certify all fiber optic cable strands with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.

4. The Contractor shall provide calibration results from the manufacturer showing the current calibration of the testers.

5. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe cable testing.

6. The Architect/Engineer may randomly select 5% of the installed strands for test verification purposes. The Contractor shall re-test these strands in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed strands at no cost to the Owner.

B. Copper Backbone Cable

1. Installed pairs shall be tested and certified in accordance with industry standards.

2. Only Manufacturer Certified Technicians shall perform testing.

3. The Contractor shall test and certify all copper pairs with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.

4. The Contractor shall provide calibration results from the manufacturer showing the current calibration of the testers.

5. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe cable testing.

6. The Architect/Engineer may randomly select 5% of the installed pairs for test verification purposes. The Contractor shall re-test these pairs in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed pairs at no cost to the Owner.

C. Category 6 UTP Cable

1. Cable links shall be tested in accordance with industry standards.

2. Only Manufacturer Certified Technicians shall perform testing.

3. The Contractor shall test and certify the structured cable system with approved field tester(s) that are within their calibration period. The Contractor shall be liable for all re-testing required in the event tests are performed with non-approved test equipment or tester(s) that are not within their calibration period.

4. No Fail or *Pass results will be accepted.

5. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe field testing.

6. The Architect/Engineer may randomly select 5% of the installed links for test verification purposes. The Contractor shall re-test these links in the presence of the Architect/Engineer and the results shall be compared to the previously Contractor submitted test results. In the event that any of the verification tests differ in results from the previously-submitted test results, all testing shall be declared a failure and the Contractor shall re-test 100% of the installed links at no cost to the Owner.

D. Grounding and Bonding

1. Main Building Ground

a. Coordinate with electrical contractor and provide a copy of their test results for the main building ground. The results shall be below 10 Ohms.

2. Two-Point Ground/Continuity Testing

a. Prior to the two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the drawings and specifications and in compliance with the TIA-607-B Standard.

b. All testing shall be conducted prior to any active equipment is installed.

c. The Contractor shall use an earth ground resistance tester that is configured for a continuity test. This is also known as a two-point tester or a “dead earth” test.

d. Prior to the two-point continuity test conduct a voltage test to ensure there is no stray voltage in the system.

e. The testing shall include but is not limited to the following points.

1) Building electrical grounding electrode and the TMGB.

2) TMGB/TGB to electrical ground in ER/TR.

3) TMGB/TGB to the building steel (if present).

4) TMGB to each TGB.

5) Building steel (if present) to the electrical ground.

f. Per the TIA-607-B, the maximum value for resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system is 100 milliohms. In the case of long TBB and Grounding Equalizer conductor runs, the resistance of the conductor must be factored into the total resistance. For example 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft.)

g. The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe field testing.

3.06 Project Closeout Documentation

A. As-Built Drawings

1. Drawings shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect/Engineer.

2. Three (3) sets of drawings depicting the condition of the structured cabling system as installed.

3. As-Built drawings shall be produced in AutoCAD 2014 or higher and provided in hardcopy and electronically in .dwg and PDF format.

4. Hardcopy drawings shall be provided in the original size as issued by the Architect/Engineer.

5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Engineer.

6. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of all equipment room/telecommunication room layouts, wall elevations, equipment rack elevations, ladder racks, cable tray, sleeves, backbone and horizontal cable pathways, workstation locations, and labeling scheme.

B. Test Documentation

1. Test documentation shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until these test results are received and approved by the Architect/Engineer.

2. Three (3) sets of test documentation for the structured cabling system as installed.

3. Test results shall be provided in hard copy and electronic format (i.e., manufacturer's proprietary testing software along with applicable reader software) and PDF electronic format.

4. Test documentation shall be bound, sectioned, and tabbed in the following sequence as applicable:

a. Tester(s) Calibration Certificate(s)

b. Inter-Building Backbone Fiber Optic Cable

c. Inter-Building Backbone Copper Cable

d. Intra-Building Backbone Fiber Optic Cable

e. Intra-Building Backbone Count Copper

f. Horizontal Category 3 Cable

g. Horizontal Category 5e Cable

h. Horizontal Category 6 Cable

i. Horizontal Category 6A Cable

j. Main Building Ground

k. Two-Point Ground/Continuity Test

C. Manufacturer's Performance Certification

1. Certificate shall be provided to the Architect/Engineer at the time of final system acceptance. Final payment will not be recommended until the certificate of certification is received and approved by the Architect/Engineer.

   a. The manufacturer of the solution shall furnish a performance certification for a period of no less than twenty (20) years starting at final system acceptance.

   b. One original and two copies of the Manufacturer's Certificate shall be provided.

D. Manufacturer's Product Warranty

1. Certificate of product warranty shall be provided to the Architect/Engineer at the time of final system acceptance. Final payment will not be recommended until this certificate of product warranty is received and approved by the Architect/Engineer.

   a. The manufacturer of the solution shall furnish an extended warranty for a period of no less than twenty (20) years starting at final system acceptance.

   b. One original and two copies of the Manufacturer's product warranty shall be provided.

E. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Engineer.

   a. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.

   b. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

END OF SECTION 27 10 00

SECTION 27 41 00 - AUDIO VISUAL SYSTEMS

PART 1 - GENERAL

1.01 This section identifies the requirements, technical design, and specifications for the audio visual systems at School of Medicine for The University of Texas Rio Grande Valley, located in Edinburg, Texas ("Owner"). The audio visual systems as specified are industry standard and may include (but not be limited to) the following: projection screen(s), and audio visual hardware as specified.

1.02 Contractor shall include materials, equipment, and labor necessary to provide a complete and functional audio visual system regardless of any items not listed or described in this specification or the associated drawings.

1.03 WARRANTY:

A. The Contractor shall include a one (1) year labor, materials and workmanship warranty on the work performed in the execution of this project to include any alterations or changes to the scope of this project through system completion and system acceptance. The warranty period shall not start until the final project completion is in writing.

1.04 GENERAL REQUIREMENTS

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 27, and shall be complied with in every respect. The Contractor shall examine all of the items which make up the Contract Documents, and shall coordinate them with the work on the project.

B. Contractor Experience Requirements

1. The Contractor shall possess all relevant manufacturer certifications (i.e. AV equipment, AV equipment mounting hardware, control system programming, AV transport, switching installation and commissioning, etc.) for both the company and individual technicians when submitting a proposal for work.

2. The Contractor shall have been in business for a minimum of five (5) years.

3. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

4. The Contractor shall have completed a minimum of three (3) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

C. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings and related contract documents.

1.05 SUBMITTAL REQUIREMENTS

A. Proposal Submittal

1. Submit the Contractors standard proposal format with the following included in the proposal or as an attachment:

a. Itemized list of all equipment and materials. This list shall contain: quantity, manufacturer, part number and description to provide a complete and functional audio visual system. Acceptance of the proposal does not accept the equipment list "as-is" and any Contractor oversights during the proposal process are to be included at no additional cost.

b. Manufacturer Product Certifications (Project Specific) for Company, Installers and Programmers including Subcontractors. (Crestron, Extron, Biamp, etc.)

c. Key staff profiles with documentation of industry certifications. Preference is given for personnel with Infocomm CTS, CTS-I and CTS-D certifications.

d. List of three (3) contractor-installed projects of a similar size and scope in operation for at least one (1) year. The Contractor shall provide the following information for each project: project name, project location, project completion date (Month/Year), brief description of project, and client point of contact name/information.

e. Provide a Warranty Statement that contains specific details on the Contractors' Warranty being proposed for this scope of work.

f. The proposal shall include an itemized breakdown of the cost of equipment, materials, labor, the standard workmanship warranty, and any shipping and taxes (if applicable). Line item pricing of equipment is not required. Do not include optional warranties or alternates in the total where applicable. Any optional warranties or alternates should be itemized separately and proposed as "in-addition-to."

2. Manufacturer product specification sheets for pre-submittal substitution requests.

a. Manufacturer product data sheets are only required when submitting a substitution request. All substitutions or alterations to the project scope must be approved in writing prior to proposal submittal.

b. For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted.

c. Submit specification sheets only. Do not submit a user or operator's manual in lieu of a specification sheet. If a specification sheet is not available from the manufacturer, submit a catalog page or the specification appendix (only) from the operation manual. The last resort acceptable submittal is a pdf of the specification section of the product from the manufacturer's website.

B. Pre-Installation Submittal

1. Contractor shall not order, purchase or install any equipment until pre-installation submittals have been accepted in writing by the Owner/Consultant.

2. Include the Proposal Submittal from the previous section in the event the Proposal Submittal was not previously provided.

3. Manufacturer product specification sheets for post award substitution requests. The requirements are the same as described in proposal substitution requests above.

4. Product Configuration Sheets.

a. Contractor shall provide a product configuration report in PDF format completed by a certified designer/engineer for the configurable device when a manufacturer

provides a tool for the applicable product. For example, but not all inclusive, a Crestron DM Switcher Configuration Report.

b. Provide projector lens calculations to include projection installation distance from screen.

5. Shop drawings of the proposed system installation.

a. Shop drawings shall be provided clearly depicting any proposed modification to the project drawings. Any modifications shall be highlighted on the shop drawings.

b. Shop drawings shall include system line diagrams, floor plans (include projector installed distance from screen with dimensioned distance), rack elevations, and/or detail drawings as required. Shop drawings shall be submitted electronically in pdf format for a 30”x42” paper size. Shop drawings shall not contain copies of, snippets of or depictions of Combs Consulting Group’s drawings.

c. Contractor shall maintain a set of shop drawings on site at all times and shall update the shop drawings on a weekly basis. Consultant drawings and specifications shall be made available during the installation of the project for reference only. Both sets of drawings are the responsibility of the Contractor to provide and maintain. Drawings shall be made available for inspection at the request of the Owner/Consultant.

6. Itemized list of all equipment and materials including any substitutions that were approved and any proposal discrepancies. This list shall contain: quantity, manufacturer, part number and description to provide a complete and functional audio visual system.

C. Project Closeout Submittal

1. The Contractor shall provide three (3) sets of comprehensive drawings accurately depicting the “as-built” condition of the audio visual systems as it was installed to the Owner/Consultant at the time of substantial completion. Final payment will not be made until these as-built documents are received and approved by the Owner/Consultant.

a. As-built drawings must be provided in original hardcopy format and on a CD-ROM and/or delivered electronically in AutoCAD rel. 2010 or higher.

2. Documentation shall include but not be limited to:

a. Equipment O & M manuals

b. Installed equipment list (manufacturer model numbers, serial numbers, installed locations, etc.)

c. Configuration information in Microsoft Excel format (IP addresses, Passwords and Usernames etc.)

d. Warranty support information

e. Documentation shall be bound, sectioned and tabbed in the following order (when applicable):

1. Equipment O&M Manuals (Bound Separately)

2. Installed Equipment List

3. Configuration Information

4. Warranty Support Information

3. All control system programming shall be delivered to the Owner. The Programmer shall transfer all source code/files related to the system. All programming shall be delivered in both compiled and un-compiled form. Upon system acceptance, ownership of the control programming shall be transferred to the Owner for their future use or modification. No claim shall be made by the programmer for continued licensing or other ongoing fees for continued usage of the control system program.

1.06 SYSTEM DESCRIPTIONS

A. CAMPUS ROOMS:

1. 130” Diagonal Screen

a. The room will consist of a flush mounted 130” diagonal motorized front projection screen and low voltage control wall plate. The screens will have an aspect ratio of 16:10 and a screen gain of 1.0

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The following sections specifically list the acceptable equipment types and items for this project.

B. Owner/Consultant will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

C. Proposed equivalent items must be approved in writing by the Owner/Consultant prior to submitting a bid. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

D. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall substitute the appropriate equivalent manufacturer's part number.

E. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished.

F. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices and intended application.

G. All wiring, equipment and installation materials shall be new and of the highest quality.

H. Labels on all wiring, materials and equipment must indicate a nationally recognized testing laboratory.

I. All new equipment shall be received, stored, and staged at the Contractor's facility until delivered and installed. Contractor shall store all materials and equipment in accordance with manufacturers' instructions in a weather-tight, secure enclosure. All equipment shall be protected from dust, debris and environmental contamination. Contractor shall be responsible for safety and security of all Contractor furnished equipment and OFE until project close-out.

2.02 EQUIPMENT

A. CAMPUS ROOMS:

1. Classroom :

a. Provide and install the projection screen(s), enclosure(s), and low voltage control keypad. Contractor will install screen enclosure prior to grid installation. Contractor will install screen roller once jobsite is clean, dust free and ready for furniture. Coordinate all structural mounting requirements, locations and elevations with the General Contractor, Owner and Consultant. Calculate all loads based on the fully installed projection screen system with the screen and roller assembly installed. 120VAC power is required for each screen. Low voltage control should be wired so that one keypad controls both screens in each room. Coordinate with manufacturer to ensure that enough additional drop is provided so that bottom of picture area is at 48"AFF (+/- 1")

b. Projection Screen 130" Diagonal Dalite Model# 34520LS. (QTY 6)

2.03 CABLE/CONNECTOR REQUIREMENTS

All indoor cabling shall be plenum rated. All outdoor cabling shall be outdoor rated and direct-burial rated when in contact with grade or within conduit in contact with grade. Coordinate all cable colors with Owner/Consultant prior to ordering or installation. Provide connectors and termination as specified by manufacturer for each application.

1. Provide all cabling with Black jacketing unless otherwise noted.

2. Acceptable manufacturers include Extron, Crestron, Belden, West Penn Wire, Gepco and Liberty. Liberty is specified to establish a cabling baseline. Cross reference equal or greater cabling and connectors when making substitutions with the acceptable manufacturers. Submit substitution requests as described in the submittal requirements section when using a manufacturer not identified as acceptable.

A. Pathway Wire Support

1. Panduit J-Mod Cable Support System

2. Erico Caddy Cat Links J-Hook Series

3. Panduit Plenum Rated Hook & Loop (Black)

B. Fire Stop

1. STI Spec Seal Part Number

2. 3M Products Part Number

C. HD-SDI | Analog Video | Genlock Cabling:

1. <50’:

a. Liberty Cable Part# 20-CMP-VID-COAX-BLK.

b. Terminate with Liberty Part# CM-RG59M-BNC or Liberty Part# 112975.

2. 50’-200’:

a. Liberty Cable Part# 18-CMP-VID-COAX-BLK.

b. Terminate with Liberty Part# CM-RG6M-BNC

D. HDBASET Cabling:

1. Liberty Cable Part# 24-4P-P-L5SH-BLK

a. Foil Shielded CAT5e Cable, Black.

b. Terminate with Liberty Part# 111S08080016C34, use copper foil conductive tape and adhesive lined heat shrink for termination.

E. Digital Audio Network Cabling:

1. Liberty Cable Part# 24-4P-P-L6SH-BLK

    a. Foil Shielded CAT6 Cable, Black.

    b. Terminate with Liberty Part# 111S08080091C34, use copper foil conductive tape and adhesive lined heat shrink for termination.

F. Network | USB/KVM Extension Cabling

1. Liberty Cable Part# 24-4P-P-L6-EN-BLK.

    a. Unshielded CAT6 cable, Black.

    b. Terminate with Liberty Part# 11108080034 RJ45 Connector.

G. HDMI | Displayport | DVI | USB Passive Cabling

1. Provide cable/signal transport of sufficient length to reach from source device to destination device. No digital cable shall exceed a length of 15 feet unless otherwise specified. Provide a high retention cable when available.

    a. HDMI - Liberty Cable Part# HD-600 Series.

H. Serial Control Cabling

1. Single data pair only.

    a. Liberty Part# 22-1P-CMP-EZ-BLK.

2. Two data pair RS232(RTS/CTS or RS485).

    a. Liberty Part# 24-2P-P485.

3. Terminate all data cabling with a reliable termination system, include hoods and retention mechanisms when available.

I. Relay | Control Cabling:

1. Liberty 18 Gauge, 2-Conductor Plenum-Rated Cabling – Part Number 18-2C-P-BLK.

J. Cresnet Cabling:

1. <500’:

    a. Liberty Part# LLINX-U-P.

2. > 500’

    a. Consult with Manufacturer/Consultant prior to ordering / installation.

K. Analog Audio | Microphone | Intercom | IFB Cabling

    a. Liberty Part# 22-1P-CMP-EZ-BLK.

b. Terminate cabling with Neutrik XX series for XLR connectors. For ¼" TRS/TS, 1/8" and RCA connectors use Rean manufactured connectors.

L. High Impedance Speaker Level Cabling (25v/70v):

1. < 300':

a. Liberty 16 Gauge, 2-Conductor Plenum-Rated Cabling – Part Number 16-2C-P-BLK.

2. 300' to 500'

a. Liberty 14 Gauge, 2-Conductor Plenum-Rated Cabling – Part Number 14-2C-P

1. Provide Cable with Black Jacket – Coordinate Cable Color with Architect.

3. > 500'

a. Consult with Manufacturer/Consultant prior to ordering / installation.

4. Terminate when available with Neutrik "Speakon" type connectors.

M. Low Impedance Speaker Level Cabling:

1. < 50':

a. Liberty 14 Gauge, 2-Conductor Plenum-Rated Cabling – Part Number 14-2C-P-BLK.

2. 50' to 100'

a. Liberty 12 Gauge, 2-Conductor Plenum-Rated Cabling – Part Number 12-2C-P-BLK.

3. > 100'

a. Consult with Manufacturer/Consultant prior to ordering / installation.

4. Terminate when available with Neutrik 'Speakon' type connectors.

N. Low Voltage Power Supply Cabling:

1. Provide cabling of sufficient gauge and conductor count as required for power supply in use. Size cabling per manufacturer's device specific minimum required voltage drop.

PART 3 - EXECUTION

3.01 CODES, STANDARDS AND REGULATIONS

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire

2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)

1. Telecommunications Distribution Methods Manual 13th Edition

2. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling

3. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Electronics Industry Alliance (EIA)

F. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998

2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998

3. FCC Part 76, Cable Television Service, revised 1998

G. Insulated Cable Engineers Association (ICEA)

1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable

2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors

3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

H. International Electrotechnical Commission (IEC)

I. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive
3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)
4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

J. International Organization for Standardization (ISO)

1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)
2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995
3. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999
4. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995
5. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

K. National Cable Television Association (NCTA)

L. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits

M. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code
2. NFPA-101, Life Safety Code
3. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
4. NFPA-780, Standard for the Installation of Lightning Protection Systems.

N. National Institute Standards and Technology (NIST)

O. Occupational Safety and Health Administration (OSHA)

P. Telecommunications Industry Association (TIA)

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
3. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, 2009
4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2008

5. ANSI/TIA/EIA–569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005

6. ANSI/TIA–569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009

7. ANSI/TIA/EIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012

8. ANSI/TIA/EIA-607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications, 2011

9. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004

Q. Underwriters Laboratories, Inc. (UL)

1. UL 510 (2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

2. UL 910 (NFPA 262 1990) Applicable Flame Test

R. In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify the Architect/Engineer in writing of any such occurrences before purchasing or installing any equipment or materials. The Architect/Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications. In the event of any conflicts between Standards and Codes the more stringent shall take precedence.

3.02 GENERAL REQUIREMENTS

A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), Project State, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect/Engineer for direction before proceeding with that part of the work.

B. The Contractor shall be responsible for coordination with other trades to ensure any conflicts or potential conflicts are resolved prior to any work beginning on the project.

C. The Contractor shall install the materials in accordance with these specifications and the manufacturer’s installation guidelines.

D. No deviations from the plans or specifications shall be made without full consent in writing of the Architect/Engineer. The Contractor shall have written approval from the Architect/Engineer for any additional work beyond the Contract Documents prior to beginning such work. If the Contractor does not obtain written approval from the Architect/Engineer prior to proceeding with the work, the contractor shall not be reimbursed for the work.

E. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, walls, roofs, or ceilings.

F. Contractor shall notify the Architect/Engineer a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect/Engineer to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

G. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap cable, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

H. Equipment and materials installed by the Contractor shall be free of defects and damage.

I. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

J. Contractor shall test all cables prior to installation. By failing to perform this testing operation, the Contractor shall accept the cable as compliant and assume all liability for the replacement of the cable at no cost to the Owner should it be found defective at a later date.

K. Contractor shall maintain a set of working specifications, design drawings, and record drawings to be kept on site at all times and shall update the record drawings with any changes on a weekly basis. Record drawings shall be made available for inspection at the request of the Architect/Engineer.

L. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

M. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

N. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect/Engineer.

O. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

P. Cables shall be properly supported in accordance with industry standards at all times. Improperly supported cables shall be corrected by the Contractor at no cost to the Owner.

Q. Contractor shall be responsible to properly protect information outlets from damage by other trades during construction.

R. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

S. The Contractor shall not install cables in conduits or sleeves without nylon bushings. Cables installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

T. Contractor shall immediately report to the Engineer any design or installation irregularities, particularly architectural elements that interfere with the intended coverage angles of loudspeakers and projector, so that appropriate action may be taken.

U. Contractor shall observe all HDBaseT Alliance cable types, lengths, bundling, termination, and patching requirements and limitations when installing audio/video over twisted-pair cabling.

V. Contractor shall observe signal separation and signal separation best practices at all times.

W. Any cabling found to be damaged shall be replaced at no cost.

X. Signals shall be separated and grouped according to type and voltage level.

Y. Contractor shall provide all required conduit and sleeves unless otherwise specified. Contractor shall provide conduit bushings even when it is the responsibility of other trades prior to cable installation.

Z. Contractor shall provide and utilize rear rack rails, lacing bars, and any other required cable dressing equipment/supplies to ensure proper industry-standard signal separation is achieved.

3.03 CABLE INSTALLATION

A. Cable Support

1. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc.

2. When cables leave the main pathway systems, they shall be installed and supported in Contractor furnished and installed j-hooks or saddle straps.

3. No cable pathway shall exceed NEC limited low voltage fill ratios.

4. The contractor shall furnish a separate j-hook or saddle strap pathway for each cable type (data, voice, video and security).

5. J-hooks and saddle straps shall be installed no more than five-feet (5’) apart on center, using only manufacturer-approved installation methods and hardware.

6. J-hooks shall be furnished with closure clips.

7. Maximum sag between supports shall not exceed twelve-inches (12”).

8. Contractor shall establish j-hook and saddle strap pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.

9. Cable Dressing

    a. No nylon cable ties shall be used at any time during the installation of the cable.

    b. Signal separation guidelines and best practices shall be observed for the complete length of all cable runs.

10. Above Ceiling

    a. Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.

        1. The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.

11. Equipment Rooms / Telecommunications Rooms

a. The Contractor shall bundle all visible cables with Contractor furnished and installed hook & loop straps.

1. Hook & loop straps shall be installed twenty-four (24) inches apart on center.

b. Plywood

1. The Contractor shall furnish and install 8’ H x 4’ W x ¾” D sheets of BC grade fire-rated plywood as when in the technology drawings.

2. The Contractor shall mount all plywood vertically starting at 24” AFF.

3. The Contractor shall cover the plywood with two (2) coats of Contractor furnished white fire retardant paint leaving exposed (1) fire rating stamp per sheet

3.04 IDENTIFICATION

A. Contractor will permanently affix labels to each cable. Labels will be affixed at a distance of 3” from the end of each cable end. If label cannot be easily viewed from this placement, cable may be placed 1” from the cable end. Cable label shall include unique cable number, source system name, source termination point, and destination system name and destination termination point. Cable labels will be identical on each cable end. Contractor to contact Consultant for additional information, if necessary.

B. Contractor will provide equipment labeling for each device front and back according to the system name used in the shop drawings. Contractor may use laminated labels (white print on black labels in front, black print on yellow in back) or equivalent.

C. Contractor will provide engraved plastic laminate labels for all racks. Rack labels to be 1” x 2” with white lettering (Arial font) on black matte finish, plastic.

1. Contractor will provide all Input/Output (I/O) panels. I/O panels will be produced from black anodized aluminum and engraved with white lettering.

3.05 TESTING REQUIREMENTS

A. Audio Visual System Testing and Configuration

1. Contractor shall un-pack and pre-test equipment prior to installation into the production environment. All configurations shall be re-verified prior to the units being placed into service.

2. Contractor shall test and commission each component per the specifications and manufacture’s installation instructions.

3. Contractor shall test and verify for full operational and network support control functionalities and connections per the specifications and manufacturer’s installation instructions.

4. All network devices shall be verified for link and auto negotiation to the highest connection rate.

5. Audio conferencing systems shall be configured to provide excellent audio performance. Verify POTS or VoIP phone system with Owner/Owner/Consultant prior to ordering and installation. Contractor shall place test calls utilizing the audio conferencing system to the system manufacturer for system calibration and testing.

6. Video conferencing systems shall be configured to provide excellent audio performance. Contractor shall place test calls utilizing the video conferencing system to the system manufacturer for system calibration and testing.

7. Contractor shall test and verify all functionalities as installed per the specifications and manufacturer's installation instructions.

8. All Crestron Digitalmedia demonstration and acceptance tests shall be performed by a Crestron Digitalmedia Certified Engineer (DMC-E).

9. Projector(s) shall be installed square in relation to the screen, and shall be adjusted to fit and fill the screen fully. Projector(s) shall be overscanned slightly into the screen border (if applicable). Projected image shall be square and level. Projector(s) shall be installed so that digital keystone correction is not utilized.

    a. In situations where keystone correction may be required, notify Owner/Consultant and coordinate solution prior to installation.

    b. Projector(s) shall be installed in such a way that the axis of the lens is perpendicular to the plane of the projection surface.

    c. In case of mismatch between projector aspect ratio and screen aspect ratio, projector shall be configured to output at screen aspect ratio.

    d. In case of mismatch between display device and signal aspect ratio, system shall be configured such that the source image best fits and fills the display device.

10. Unless noted otherwise, all projection screens shall be mounted with the lower edge of the viewable image area at 48" A.F.F.

    a. Provide additional black drop as required.

11. Video display system(s) minimum test protocols:

    a. Test each video display system with test signal generating equipment capable of outputting the following resolutions. (Ultra HD and 4K resolutions required only when testing 4K systems)

        1. 4:3 - 640x480, 800x600, 1024x768

        2. 16:9 - 1280x720 (720p), 1366x768, 1600x900, 1920x1080 (1080p), 3840x2160 (Ultra HD), 4096x2160 (DCI 4K).

        3. 16:10 - 1280x800, 1440x900, 1680x1050, 1920x1200

    b. Test signal generator must be capable of outputting the correct signal protocol using the applicable connectivity (RCA/BNC, S-Video, VGA, DVI, HDMI, Displayport, Etc.).

    c. The test signal generator must be capable of outputting a standard set of color bars, grid pattern, grayscale, checkerboard and multi-burst.

END OF SECTION – 27 41 00

SECTION 28 08 00 - COMMISSIONING OF FIRE ALARM SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for Fire Alarm/Notification systems, assemblies, controls, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

1.2 RELATED SECTIONS

A. SECTION 01 91 00 – GENERAL COMMISSIONING REQUIREMENTS

B. SECTION 22 08 00 – COMMISSIONING OF FIRE PROTECTION SYSTEMS

C. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS

D. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

E. SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

1.3 DEFINITIONS

A. Refer to Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.4 SUBMITTALS

A. Certificate of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for details of contractor’s responsibilities related to commissioning.

B. Perform commissioning tests at the direction of the CxA.

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

F. Functional testing of systems will be carried out solely by contractor’s personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.6 CxA'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 28 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Mechanical systems.

C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

D. Test all operating modes, interlocks, control responses, and responses to normal, abnormal, and emergency conditions, and verify proper response of building automation system controllers and sensors.

E. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that Fire Alarm/Notification systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that testing procedures for Fire Alarm systems have been completed and submitted, discrepancies corrected, and corrective work approved.

C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.4 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Plumbing systems.

B. Provide measuring instruments to record test data as directed by the CxA.

3.5 RE-TESTING

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Fire Alarm systems.

3.6 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for Fire Alarm systems to be commissioned.

END OF SECTION

SECTION 28 13 00 – ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 This section identifies the technical design and specification requirements for the access control system for the UTRGC SOM Admin Building for The University of Texas Rio Grande Valley, ("Owner"). The access control system as specified is a Vanderbilt Industries system and includes card readers, door position sensors, control panels, access control software, and access control cabling as specified.

1. Security Contractor shall provide all materials, equipment, and labor necessary to provide a complete and fully functional access control system regardless of any materials and/or equipment not listed or described in this specification and/or supplementary drawings.

2. The Security Contractor shall possess all relevant Manufacturer Certifications (i.e. hardware installation, software installation, and programming, etc.) for both the company and individual technicians prior to submitting a bid for the work. The certifications for the relevant manufacturers shall be submitted as part of the bid documents.

3. The Security Contractor and any subcontractors involved in the installation of the system shall have and maintain the State of Texas, Department of Public Safety private security license for the sales/installation and service of security systems. Each employee of the company shall have and maintain the State of Texas, Department of Public Safety private security license duration of the project. The owner may at any time during the installation ask to see a copy of the company's and/or individual employees the State of Texas, Department of Public Safety private security licenses.

4. The Security Contractor is responsible for obtaining complete construction documents for bidding purposes, including but not limited to; TS-Series construction documents, Equipment Schedules, specifications and any supplementary addenda. Contractors that bid off of incomplete documents shall be liable for any materials and/or services required as indicated or specified in the complete construction document set. In the event of any discrepancies between the documents the greater quantities or scope shown on drawings or indicated in the specification shall be provided by the contractor.

5. The Security Contractor shall provide the owner as part of their bid submission detailed information on manpower resources as well as a detailed project schedule outlining milestones, activities, deliverables, and start and finish dates.

6. The Security Contractor shall provide as part of their bid submission detailed information on their safety plan and safety records for the past 24 months. Additional the Security Contractor shall provide the owner as part of their bid submission details on their Quality Assurance, and Quality Control (QA/QC) processes and practices to include but not limited to information on compliance, quality assurance, validation, training records, and document management related to the installation of the security systems.

7. The Security Contractor shall provide as part of their bid submission details on their Cybersecurity processes and practices related to the installation and/or servicing of security system software and IP devices such as cameras, IP door controllers and card readers systems. The Security Contractors Cybersecurity processes and practices should always take into account the protection of the Owners technology infrastructure.

8. Security Contractor shall provide a comprehensive (labor and materials) 1-year on-site warranty on all products provided under this specification. The warranty period shall begin after a formal owner acceptance of the card access system. Warranty shall include all applicable Vanderbilt Industries warranties on all eligible equipment and include all necessary services.

9. The contractor is invited to provide the owner with information on extended warranty programs as well as any software support agreements that may be required for the Vanderbilt Industries system. This information shall be provided as part of the security contractors bid submission.

10. The security contractor will provide as part of their bid submission, details on the hours of operation for their service and installation departments as well as all services rates and any trip charges.

11. The security contractor shall provide as part of their bid detailed information on the leadership, project management and service management personal and contact information for each member of leadership, project management, and service management personnel.

1.2 REQUIREMENTS INCLUDED

A. Contractor Requirements

B. Acceptable Manufacturers

C. Codes, Standards and Regulations

D. General Requirements

E. System Requirements

F. Testing Requirements

G. Project Closeout Documentation

H. Attachments

1.3 RELATED REQUIREMENTS

B. The Drawings, Specifications, General Conditions, Supplementary General Conditions and other requirements of Division 1, apply to the work specified in Division 28, and shall be complied with every respect. The Contractor shall examine all of the documents, which make up the Contract Documents, and shall coordinate them with the work on the TS-Series Drawings and Division 28 of these Specifications.

1.4 CONTRACTOR EXPERIENCE REQUIREMENTS

A. The Prime Security Contractor shall be a Vanderbilt Industries Authorized Partner and Installer prior to submitting a proposal for the work.

B. The Contractor shall possess all relevant Manufacturer Certifications for the company and all installers prior to submitting a proposal for the work. Contractor shall provide a list of their installers with their work experience, training history and manufacturer’s certifications for the Company and installers.

C. Installers must be certified, trained and experienced on the specific installation, termination and testing of the systems as specified.

D. Contractors shall have an onsite Project Manager and Engineer.

E. The Contractor shall certify, and the Manufacturer of the solution shall warrant the solution for a period of no less than one (1) year.

F. The Contractor shall be an established business with local support and shall have been in business for a minimum of five (5) years.

G. The Contractor shall have prior experience with projects of a similar size and scope. The Contractor shall provide a minimum of five (5) installed systems comparable to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year. The Contractor shall provide the following information for each reference: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

H. Past performance with the Owner is a selection criterion. Experience related to any past or present project with the Owner should be disclosed with bid response.

I. Qualified Contractors should submit proof of all certifications and experience detail with bid response and product submittals.

1.5 SUBMITTALS

A. To Be Submitted with Proposal

1. Contractor shall submit an itemized listing of all equipment, materials and labor required for the installation of the Access Control System as specified herein. This listing shall be provided in printed form and electronic format (Microsoft Excel) and shall contain: Part Number, Description, Unit of Measure, Unit Cost, Quantity, Labor Cost and Extended Cost to provide a complete and functional cable plant system. Attachment "A" attached to these specifications shall be used for this purpose.

2. Manufacturer Certifications for Company as identified in Contractor Experience Requirements.

3. Manufacturer Training Certifications for Installers as identified in Contractor Experience Requirements.

4. Project Manager and Engineer Certification as identified in Contractor Experience Requirements.

5. Manufacturer Certification/Warranty offering as identified in Contractor Experience Requirements.

6. Proof of established business with local support that has been in business for a minimum of five (5) years as identified in Contractor Experience Requirements.

7. Project/client references as identified in Contractor Experience Requirements.

8. Past performance with owner as identified in Contractor Experience Requirements.

B. Pre-Installation

1. Original Equipment Manufacturer (OEM) documentation for each component proposed must be provided to Owner, which certifies performance characteristics. Contractor shall not purchase or install any equipment until OEM documentation has been received and approved by the Architect/Engineer.

2. Product data sheets for all proposed system components. Product data sheets shall include: an equipment schedule listing of all system components to be installed in the project and the manufacturer's product reference and specification literature for all products to be utilized and/or installed in the project. Contractor shall not purchase or install any equipment until product data sheets have been received and approved by the Architect/Engineer.

3. Contractor shall provide to owner's representative shop drawings of the proposed layouts of equipment. Shop drawings shall include card reader locations, door position sensor locations, access control panel elevations to include layout and power supply locations, system schematics, and riser diagrams. These detailed shop drawings shall be submitted on 30" X 42" bond paper. Contractor shall not install any equipment until shop drawings have been received and approved by the Architect/Engineer.

4. Manufacturer Certifications for Company as identified in Contractor Experience Requirements.

5. Manufacturer Training Certifications for Installers as identified in Contractor Experience Requirements.

6. Manufacturer Certification/Warranty offering as identified in Contractor Experience Requirements.

C. Post Installation

1. Contractor shall prepare, update and make available to the Architect/Engineer a comprehensive three (3) copy set of drawings accurately depicting the "as-built" condition of the access control system as it was installed. As-Built drawings must be provided in original hardcopy format and on a CD-ROM in AutoCAD rel. 2010 or higher. The Contractor shall prepare, update, and make available to the Consultant a comprehensive set of "as built" drawings using the original scale, indicating exact dimensions and locations of all card readers, locksets, door position sensors, access control panels, and labeling scheme. These drawings shall be turned over to the Consultant at the time of final systems acceptance of the access control installation. Final payment will not be made until these drawings are received and approved by the Architect/Engineer.

2. The Contractor shall provide three (3) sets of documentation for the access control system to the Architect/Engineer at the time of final systems acceptance. Test results shall be provided in original hardcopy format and on a CD-ROM. Final payment will not be made until these test results are received and approved by the Architect/Engineer. Test documentation shall be bound, sectioned and tabbed in the following order:

3. The Contractor shall furnish the original Certificate of Certification/Warranty to the Architect/Engineer at the time of final systems acceptance. Final payment will not be made until this Certificate of Warranty is received and approved by the Architect/Engineer.

4. Contractor shall provide warranty information to include the name, address and phone number of contacts for warranty call outs. Final payment will not be made until this warranty information is received and approved by the Architect/Engineer.

PART 2 – PRODUCTS

2.1 The following sections specifically list the acceptable equipment types and items for this project. Proposed equivalent items must meet or exceed these specifications and the specifications of the listed item. In the event a specified manufacturer's part number has changed or is no longer valid, Contractor shall substitute the appropriate equivalent manufacturer's part number. Owner or Owner's designate will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to installation. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished. Any Owner-furnished materials or equipment not installed in the project shall be returned to the Owner. Contractor shall store all materials and equipment in accordance with manufacturers' instructions in a weather-tight, secure enclosure. Contractor shall be responsible for safety and security of all Owner-furnished materials until project is complete and accepted by Owner.

2.2 ACCEPTABLE MANUFACTURERS

A. Access Control System Software

1. Existing Software - Vanderbilt Industries

B. Control Panels

1. Vanderbilt Industries – VRCNX-R Reader Controller

C. Power Supply

1. Schlage – PS906 w/BBK Power Supply

D. Power Supply at Doors

1. Schlage – PS914-2RS Power Supply

E. Back Up Power Supply

1. The Security contractor shall provide and install back up power supply(s) for the doors noted on the security drawings (TS-201 and TS-202)
2. The backup power supply(s) shall provide an uninterruptible source of power for the electronic locking hardware, card readers, request to exit devices and access control panels associated with the operation of the doors.
3. The backup power supply(s) shall provide uninterruptible power to the security devices noted at the doors for a period after power loss to the building of no less than 90 minutes.

1. Schlage- 900-BB Battery Backup, with 12VDC, 7Ah Gel Sealed Rechargeable Battery (2 included) 5 Year Service Life
2. Approved Equivalent

F. Reader Interface at Door

1. Vanderbilt Industries – VRINX Reader Interface at Door

G. Card Reader

1. Schlage – MT15 Multi-Tech Card Reader
2. Schlage – MTMS15 Multi-Technology Magnetic Stripe Reader

H. Concealed Desk Mounted Switch

1. SDC - SDC Desk Switch, Under Desk Mount, (1) Momentary SPDT Push Switch – 15-2
2. Approved Equivalent

I. Access Control Cabling

1. Superior Essex Plenum-Rated Composite Cable
2. Approved Equivalent

J. Pathway Cable Support

1. Panduit J-Mod Cable Support System
2. Erico – Caddy CAT LINKS J-Hook Series
3. Panduit Plenum Rated Hook & Loop (Black)

K. Labeling

1. Panduit Self-Laminating Labels
2. Approved Equivalent

L. Fire Stop

1. STI Spec Seal
2. 3M Products

M. The Security Contractor shall provide 10% share parts for all major security systems components to include:

1. Security cameras
2. Card readers
3. Security card access control panels
4. Security locking power supplies

The security contractor will provide the new share parts in their factory boxes along with any related paperwork to the owner as part of the system commissioning and close out.

PART 3 - EXECUTION

3.1 CODES, STANDARDS AND REGULATIONS

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Electronics Industry Alliance (EIA)

E. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998
2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998

F. International Electrotechnical Commission (IEC)

G. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System
2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive

3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)

H. International Organization for Standardization (ISO)

I. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)

J. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

K. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

L. National Cable Television Association (NCTA)

M. National Electrical Code (NEC)

N. National Electrical Manufacturers Association (NEMA)

O. National Fire Protection Association (NFPA)

P. NFPA-70, National Electrical Code

Q. NFPA-75, Protection of Electronic Computer Data Processing Equipment.

R. NFPA-101, Life Safety Code

S. NFPA-297, Guide on Principles and Practices for Telecommunications Systems

T. NFPA-780, Standard for the Installation of Lightning Protection Systems.

U. National Institute Standards and Technology (NIST)

V. Occupational Safety and Health Administration (OSHA)

W. Telecommunications Industry Association (TIA)

X. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009

Y. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009

Z. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, 2009

AA. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2008

BB. ANSI/TIA/EIA–569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005

CC. ANSI/TIA–569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009

DD. ANSI/TIA-606-A, Administration Standard for Commercial Telecommunications Infrastructure, 2007

EE. ANSI-J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications, 1994.

FF. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004

GG. ANSI/TSI/EIA-TSB72, Centralized Optical Fiber Cabling Guidelines, 1995

HH. ANSI/TIA/EIA-TSB75, Additional Horizontal Cabling Practices for Open Offices, 1996.

II. ANSI/TIA/EIA-TSB95, Additional Transmission Performance Guidelines for 4-Pair 100-OHM Category 5 Cabling, 1999.

JJ. Underwriters Laboratories, Inc. (UL)

In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify in writing to the Architect/Engineer of any such occurrences before the purchasing of any equipment, materials and/or installation by the Contractor. The Architect/Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.

3.2 GENERAL REQUIREMENTS

A. In the installation of this work, the Contractor shall comply in every way with the requirements of local and City of Edinburg laws, ordinances, and rules, the laws of the State of Texas, the National Board of Fire Underwriters, and the National Electrical Code. If, in the opinion of the Contractor, there is anything in the plans or specifications that will not strictly comply with the above laws, ordinances, and rules, the matter shall be referred to the attention of the Architect/Engineer for a decision before proceeding with that part of the work.

B. No change in the plans or in the specifications shall be made without full consent in writing of the Architect/Engineer.

C. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, or partition ceilings.

D. The Contractor shall install the materials in accordance with the manufacturers' guidelines and specifications.

E. The Contractor shall promptly correct all system discrepancies or defects for which the Contractor is responsible.

F. The Contractor shall coordinate all work with the Architect/Engineer prior to purchase of products or installation of access control components.

G. The Contractor shall submit product data sheets for all materials to the Architect/Engineer prior to the purchase or installation of access control components.

H. The Contractor shall maintain a work area free of debris, trash, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

I. The Contractor shall be certain that all work areas are in compliance with the Occupational Safety and Health Administration (OSHA) regulations.

J. The Contractor shall have written approval from the Architect/Engineer for any additional work outside the Contract Documents prior to beginning such work.

K. The Contractor shall be responsible for testing all cable prior to the installation of the cable. If the Contractor fails to perform this testing operation, the Contractor shall accept the cable as good and assume all liability for the replacement of the cable should it be found defective at a later date.

L. The Contractor shall be responsible for returning any and all penetrations through rated walls or floors made for communications cable to their pre-penetration rating.

M. The Contractor shall maintain a set of working specifications and drawings on site at all times and shall be responsible for keeping the drawings updated on a minimum of a weekly basis. These working drawings shall be made available for inspection at the request of the Architect/Engineer or the Owner.

N. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment or wiring are required, these units shall be the standard product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.

O. All wiring, equipment and installation materials shall be new and of the highest quality. Cable, equipment and installation materials shall be delivered and stored in a clean, dry space at the Contractors expense. Materials and equipment will be properly packaged in factory-fabricated type containers and protected from the environment, damaging fumes, construction debris, and traffic, etc. until the job is installed or completion of the project.

P. Labels on all wiring, materials, and equipment must show that a nationally recognized testing laboratory lists these. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer, which certifies performance characteristics and which meet ANSI/TIA/EIA 568-B.1 standard.

Q. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be allowed unless specifically approved or specified by the Architect/Engineer.

R. All material used in the installation shall be made of corrosion-resistant material, such as plastic, anodized aluminum, or brass and be resistant to fungus growth and moisture deterioration. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.

S. All cable install in plenum rated environment shall meet or exceed the Underwriters Laboratories (UL) fire rated cable insulation requirements.

T. The Card reader, door contact, and request to exit are powered from the specified Superior Essex Plenum rated Access Control Composite Cable. This composite cable ties back into the respective control panel/card located in the nearest MDF/IDF. Pairs are as follows: Card Reader 22 AWG x 3 twisted pairs, Request to Exit 22 AWG x 4 conductors, Door Contact 22 AWG x 2 conductors.

U. The division 26 contractor will provide and install all security pathways as shown in the technology drawings to include conduits pull boxes, and back boxes with pull strings.

V. The division 26 contractor will provide all access control power at the doors and power to the

access control panels. The Div 26 contractor shall coordinate with the Div 28 contractor on all power requirements. It is the responsibility of the Div 26 contractor to price all access control alternate pathways and power separately.

W. The Div 28 contractor shall perform all terminations and testing at the hardware side and security panels for all security devices. It is the responsibility of the Div 28 contractor to price all access control alternate devices and installed separately.

X. The Div 28 contractor shall provide and install all security devices and security cabling such as but not limited to security wiring at the door and security panel, access control panels, card readers, request to existing devices, and door contacts.

Y. The Div 8, 26, and 28 contractors shall perform onsite coordination in order to facilitate a timely and accurate installation of pathways, wiring, hardware, and security devices as indicated on the security drawings.

Z. The contractor shall take positive measures to prevent the introduction of cybersecurity threats to the Owners technology infrastructure. These measures shall include but are not limited to:

a. The contractor shall scan contractor-owned equipment for cyber threats such as viruses, malware, ransomware, etc., prior to connecting the contractor-owned devices to the Owners network

b. Coordinate with the manufacturer to ensure newly procured equipment does not have any cybersecurity notices, bulletins or alerts. Provide a letter to the Engineer with the submittal documents confirming there are no active or known cyber threats.

c. Ensure all technicians installing or configuring equipment are trained in the prevention of introduction of cyber threats to electronics, i.e. servers, surveillance cameras, and other associated equipment.

d. The contractor shall assess whether or not there are any cyber threats / vulnerabilities associated with the specified equipment, prior to procurement/installation. If cyberthreats are discovered, notify the Architect/Engineer with 24 business hours. Provide the make and model of the associated equipment and the vulnerability.

3.3 SYSTEM REQUIREMENTS

A. Contractor is responsible for furnishing materials as required to provide a complete and functioning access control system. Where quantities are not noted, they may be obtained from the drawings. In the event of discrepancy between the specifications and the drawings, the greater quantity shall be furnished

B. Control Panel

1. Contractor shall provide installation in accordance with the Manufacturer’s installation instructions.

2. Contractor shall coordinate exact control panel location prior to installation.

3. Contractor shall energize and commission equipment in accordance with manufacturer’s

instructions and guidelines.

C. Network Interface

1. Contractor shall provide installation in accordance with Manufacturer's installation instructions.

2. Contractor shall coordinate exact device location prior to installation

3. Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines

4. Contractor shall program all network address information for network interface and ensure communication is established between the control panel and the access control software.

D. Card Reader

1. Contractor shall furnish and install as indicated on the technology drawings.

2. Contractor shall provide installation in accordance with Manufacturer's installation instructions.

3. Contractor shall coordinate exact card reader location prior to installation

4. Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines

5. Contractor shall ensure communication is established between the card reader and control panel.

E. Electrified Lockset

1. Contractor shall coordinate with door hardware contractor to ensure an interface power transfer device is provided for the electrified lockset.

2. Contractor shall ensure electrified lockset is incorporated into the access control panel to allow for actuation of lockset via the access control software.

F. Concealed Desk Mounted Switch

1. Contractor shall furnish and install as indicated on the technology drawings.

2. Contractor shall provide installation in accordance with Manufacturer's installation instructions.

3. Contractor shall coordinate exact device location prior to installation.

G. Power Supplies

1. Contractor shall provide installation in accordance with Manufacturer's installation instructions.

2. Contractor shall coordinate exact device location prior to installation

3. Contractor shall energize and commission equipment in accordance with manufacturer's

instructions and guidelines

H. Access Control Cabling

1. Contractor shall install a 20-foot service loop at the ends of each wire to be coiled, mounted and stored above card reader door.

2. Contractor shall install an 8-foot service loop at the ends of each wire to be coiled, mounted and stored at the access control panel.

3. Wire shall be routed using pathways as indicated in the technology drawings.

I. Pathway Cable Support

1. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.

2. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or saddle straps.

3. No cable pathway shall exceed 40% fill ratio.

4. The contractor shall furnish a separate j-hook or saddle strap pathway for each wire type.

5. J-hooks and saddle straps shall be installed no more than five-feet (5’) apart on center, using only manufacturer-approved installation methods and hardware.

6. J-hooks shall be furnished with closure clips.

7. Maximum sag between supports shall not exceed twelve-inches (12”).

8. Contractor shall establish j-hook and saddle strap pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.

9. No nylon cable ties shall be used at any time during the installation.

10. Contractor shall furnish and installed plenum-rated hook & loop straps in plenum-rated airspaces.

11. Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.

12. Contractor shall bundle all visible wires with Contractor furnished and installed hook & loop straps.

13. Hook & loop straps shall be installed twenty-four (24) inches apart on center.

J. System Labeling

1. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.

2. Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications Rooms.

3. Cables shall be labeled within (6) inches from the termination point at the device end.

4. Cables shall be labeled identically at both ends.

5. Access control system cable labels shall contain the device number, wire origin room number, wire designation room number, and wire type (i.e. CR01/123-134/18AWG-6CONDUCTOR). In instances where no origin room number exists, utilize device number wire destination room number, and wire type (i.e. CR01/134/18AWG-6CONDUCTOR).

6. Access control equipment to be labeled shall include but not limited to access control workstation, control panels, network interface devices. Coordinate name, font style, and devices to be labeled with Owner or Owner's representative before labeling. Provide computer generated labels, handwritten labels will not be accepted.

3.4 TESTING AND TRAINING REQUIREMENTS

A. TESTING

1. Contractor shall test and commission each component of the access control system to ensure the system is function as intended per the specification and manufacturer's installation instructions.

2. Coordinate final network (ports, IP addresses, programming, etc.) requirements with Architect and Owner.

3. Coordinate with the Owner to resolve any programming and communication problems that occurred during the test.

4. The Security Consultant will prepare a punch list of items identified during the test that require correction before final acceptance.

5. Upon completion of testing and coordination, the Owner and the Security Consultant will conduct a final acceptance test.

B. TRAINING

1. Contractor shall provide user training at a pre-coordinated time and date to review the operation of the new Vanderbulit Access Control System. Aspects of training shall include at a minimum:

a. System Configuration
b. All operating procedures
c. Cardholder input and deletion procedures
d. Alarm acknowledgement
e. Basic Troubleshooting
f. Warranty and Service Procedures

3.5 PROJECT CLOSEOUT DOCUMENTATION

1. The contractor shall provide a designated representative as Project Manager and be available for all project meetings and all inspection activities.

2. All project correspondence shall be sent in hardcopy to all relevant parties via letter, facsimile or

email. Verbal agreements, arrangements or other communications shall not be binding on either party or have precedent for the duration of Contract.

3. The contractor shall present an installation schedule prior to beginning the installation. All project activities shall be coordinated in advance of such stated activities.

4. Upon successful operation and cutover of the system, the contractor shall notify the Architect/Engineer that the installation is substantially complete at which time the designated representative shall perform a formal Substantial Completion inspection to verify the work. Any and all discrepancies will be documented. The Contractor shall have ten (10) working days to resolve any and all system discrepancies noted on the Certificate of Substantial Completion.

5. Title for all equipment (Hardware and Software) shall not pass to the Owner from the contractor until the system is accepted and both the Owner and contractor execute the Certificate of Systems Acceptance.

6. Contractor shall provide the Owner one (1) original and two (2) identical copy sets of the system installation and O&M documentation at the time of Substantial Completion. This documentation at a minimum shall contain the following:

    A. Contractor shall provide product cut-sheets and manuals for every hardware and software product installed as part of this project.

    B. Contractor shall provide the Owner a complete listing of all equipment and software installed as part of this project. This data shall be shown on a spreadsheet format, indicating, Manufacturer, Description, Model #, Serial # and all applicable revision or release information.

    C. Contractor shall provide the Owner access control system diagrams indicating physical arrangement, IP addressing, system programming, etc.

    D. Contractor shall provide the Owner all original and archival copies of the operational and application software with applicable software licenses and code keys. All software must be submitted in the original packaging and contain original documentation.

    E. Contractor shall provide a cut-sheet for each component installed in the network.

    F. Contractor shall provide the Owner with a logical installation drawing indicating the exact dimensions and locations of all equipment room/telecommunication room wall elevations, control panel layouts, card reader locations, and labeling scheme.

    G. Contractor shall provide all applicable systems documentation in Hard and Softcopy as applicable.

Attachment A

Provide an itemized listing of all equipment and material required to meet the specifications for the Access Control System. This listing shall include Part Number, Description, Unit of Measure, Unit Cost, Quantity, Labor Cost and Extended Cost.

Part Number	Description	Unit of Measure	Unit Cost	Quantity	Labor Cost	Extended Cost

Total Equipment and Materials	**$ -**
Total Labor and Installation	**$ -**
Grand Total	**$ -**

END OF SECTION 28 1300

SECTION 28 23 00 - VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.01 This section identifies the requirements, technical design, and specifications for the video surveillance system at the UTRGC SOM Admin Building for The University of Texas Rio Grande Valley, located in Brownsville, Texas (Owner). The electronic surveillance system as specified is an industry-standard and includes interior and exterior surveillance cameras, network video recorder, and electronic surveillance cabling as specified.

a) Security Contractor shall provide all materials, equipment, and labor necessary to provide a complete and fully functional access control system regardless of any materials and/or equipment not listed or described in this specification and/or supplementary drawings.

b) The Security Contractor shall possess all relevant Manufacturer Certifications (i.e. hardware installation, software installation, and programming, etc.) for both the company and individual technicians prior to submitting a bid for the work. The certifications for the relevant manufacturers shall be submitted as part of the bid documents.

c) The Security Contractor and any subcontractors involved in the installation of the system shall have and maintain the State of Texas, Department of Public Safety private security license for the sales/installation and service of security systems. Each employee of the company shall have and maintain the State of Texas, Department of Public Safety private security license duration of the project. The owner may at any time during the installation ask to see a copy of the company's and/or individual employees the State of Texas, Department of Public Safety private security licenses.

d) The Security Contractor is responsible for obtaining complete construction documents for bidding purposes, including but not limited to; TS-Series construction documents, Equipment Schedules, specifications and any supplementary addenda. Contractors that bid off of incomplete documents shall be liable for any materials and/or services required as indicated or specified in the complete construction document set. In the event of any discrepancies between the documents the greater quantities or scope shown on drawings or indicated in the specification shall be provided by the contractor.

e) The Security Contractor shall provide the owner as part of their bid submission detailed information on manpower resources as well as a detailed project schedule outlining milestones, activities, deliverables, and start and finish dates.

f) The Security Contractor shall provide as part of their bid submission detailed information on their safety plan and safety records for the past 24 months. Additional the Security Contractor shall provide the owner as part of their bid submission details on their Quality Assurance, and Quality Control (QA/QC) processes and practices to include but not limited to information on compliance, quality assurance, validation, training records, and document management related to the installation of the security systems.

g) The Security Contractor shall provide as part of their bid submission details on their Cybersecurity processes and practices related to the installation and/or servicing of security system software and IP devices such as cameras, IP door controllers and card readers systems. The Security Contractors Cybersecurity processes and practices should always consider the protection of the Owners technology infrastructure.

h) Security Contractor shall provide a comprehensive (labor and materials) 1-year on-site warranty on all products provided under this specification. The warranty period shall begin after a formal owner acceptance of the card access system. Warranty shall include all applicable Video product warranties on all eligible equipment and include all necessary services.

i) The contractor is invited to provide the owner with information on extended warranty programs as well as any software support agreements that may be required for the Video system. This information shall be provided as part of the security contractors bid submission.

j) The security contractor will provide as part of their bid submission, details on the hours of operation for their service and installation departments as well as all services rates and any trip charges.

k) The security contractor shall provide as part of their bid detailed information on the leadership, project management and service management personal and contact information for each member of leadership, project management, and service management personnel.

1.02 Requirements

A. Contractor Experience Requirements

B. Submittal Requirements

C. Acceptable Manufacturers

D. Codes, Standards and Regulations

E. General Requirements

F. System Requirements

G. Testing Requirements

H. Training Requirements

I. Project Closeout Documentation

J. Attachments

1.03 Related Requirements

A. The Drawings, Specifications, General Conditions, Supplementary General Conditions, and other requirements of Division 1 apply to the work specified in Division 28, and shall be complied with in every respect. The Contractor shall examine all of the items which make up the Contract Documents, and shall coordinate them with the work on the project.

B. Contractor Experience Requirements

1. The Contractor shall possess all relevant Manufacturer Certifications (i.e. hardware installation, software installation and programming, etc.) for both the company and individual technicians prior to submitting a bid for the work.

2. The Contractor shall have been in business for a minimum of five (5) years.

3. The Contractor shall have a local office with local technicians and an adequate workforce to complete this project within a 75-mile radius of the project site.

4. The Contractor shall have completed a minimum of five (5) projects similar in size and scope to the Owner's installation, where the systems have been in continuous satisfactory operation for at least one (1) year.

C. Subcontractors shall be identified at the time of bid and comply with the requirements and intentions of these specifications, associated drawings, and related contract documents.

1.04 Submittal Requirements

A. Pre-Installation Submittal

1. Contractor shall not order, purchase, or install any equipment until pre-installation submittals have been accepted in writing by the Architect/Engineer.

2. Manufacturer product data sheets for each proposed system component.

   a. For product data sheets containing more than one (1) part number or product, the Contractor shall clearly identify the specific part number or product being submitted.

3. Shop drawings of the proposed system installation.

   a. Shop drawings shall include surveillance camera locations, rack elevations, installation typical details, preliminary cable numbers, proposed cable pathways, system schematics, and riser diagrams. Shop drawings shall be submitted on 30" X 42" bond paper.

   b. Contractor shall maintain a set of shop drawings on site at all times and shall update the shop drawings on a weekly basis. Shop drawings shall be made available for inspection at the request of the Architect/Engineer.

4. Itemized list of all equipment, materials and labor required for the installation of the electronic surveillance system as specified herein.

   a. This list shall be provided in printed and electronic format (Microsoft Excel) and shall contain: Part Number, Description, Unit of Measure, Unit Cost, Quantity, Labor Cost and Extended Cost to provide a complete and functional electronic surveillance system. Attachment "A" attached to these specifications shall be used for this purpose.

5. Estimated cable count required for the electronic surveillance system listed per Equipment Room and or Telecommunications Room.

   a. This listing shall be provided in printed form and electronic format (Microsoft Excel). Attachment "B" attached to these specifications shall be used for this purpose.

6. Manufacturer Product Certifications for Company.

7. Manufacturer Product Certifications for Installers.

8. Manufacturer Warranty letter.

9. Documentation indicating that Contractor has been in business for (5) years.

10. Address of Contractor's local office within a 75-mile radius of the project site.

11. Quantity of full time local technicians within a 75-mile radius of the project site.

12. List of five (5) contractor-installed projects of a similar size and scope in operation for at least (1) year. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, Brief Description of Project, Client Point of Contact Name and Phone Number.

13. List of completed and ongoing projects with the Owner. The Contractor shall provide the following information for each project: Project Name, Project Location, Project Start Date, Project Completion Date, Project Start Cost, Project Completion Cost, and Brief Description of Project.

PART 2 PRODUCTS

2.01 General Requirements

A. The following sections specifically list the acceptable equipment types and items for this project.

B. Architect/Engineer will have final determination of acceptability of all proposed equipment and must approve submitted equipment prior to purchase or installation.

C. Proposed equivalent items must be approved in writing by the Architect/Engineer prior to submitting a bid. Proposed equivalent items must meet or exceed these specifications and the specifications of the specified item.

D. In the event a manufacturer's specified product or part number has changed or is no longer available, Contractor shall substitute the appropriate equivalent manufacturer's part number.

E. In the event of a discrepancy between the specifications and the drawings, the greater quantity and/or better quality will be furnished.

F. For listed products with no part number specified, Contractor shall provide a product that meets the performance requirements of these specifications, industry standard practices, and intended application.

G. All wiring, equipment, and installation materials shall be new and of the highest quality.

H. Labels on all wiring, materials, and equipment must indicate a nationally recognized testing laboratory.

I. Original Equipment Manufacturer (OEM) documentation must be provided to the Architect/Engineer which certifies performance characteristics and compliance with industry standards.

2.02 Acceptable Manufacturers

A. Electronic Surveillance System Software/Hardware

1. Electronic Surveillance Management Software

a. Genetec / Omnicast

b. Electronic Surveillance System Licensing

1) As required

2. Electronic Surveillance System Server

a. Network Server

1) Dell R520 (with redundant power supply, RAID, 2x500GB O/S drives, 12x8TB storage drives, 8GB RAM, Windows Server 2012)

b. Equipment Rack

1) Chatsworth Standard Rack – Part# 55053-703

c. Two Post Rack Shelf

1) Chatsworth 40751-719 Double Sided Steel Shelf, Black

B. Surveillance Cameras

1. Interior Wall Mounted Camera

a. Fixed Dome

1) Axis P3354

2) Axis P3384V

2. Exterior Camera

a. Fixed Dome

1) Axis P3364LVE

b. Pan Tilt Zoom

1) Axis Q6114-E

C. Power Equipment

1. Power Supply

a. 12 Volt DC

1) Altronix or approved equal.

b. Surge Protection

1) Atlantic Scientific
2) Ditek

c. Uninterruptable Power Supply

1) APC Smart-UPS

D. Electronic Surveillance System Cabling

1. Category 6 installed by others.

E. Pathway Cable Support

1. Pathway Cable Support installed by others.

F. Labeling

1. Permanent Labels for Copper Cables

a. Panduit Self-Laminating Labels

G. Fire Stop

1. STI Spec Seal

2. 3M Products

H. The Security Contractor shall provide 10% share parts for all major security systems components to include:

1. Security cameras
2. Card readers
3. Security card access control panels
4. Security locking power supplies

The security contractor will provide the new share parts in their factory boxes along with any related paperwork to the owner as part of the system commissioning and close out.

2.03 Cameras

A. Camera type, location, enclosure and mounting requirements shall be as indicated on the drawings.

B. All interior cameras are to be wall mounted as indicated on drawings.

C. Connect to data cable provided by other as indicated on technology and security drawings.

D. Contractor shall provide necessary Category 6 patch cable to connect the camera to the provided data connection as indicated on the technology and security drawings.

E. Camera will receive power via Ethernet from existing POE Switch, unless noted otherwise.

F. Provide, terminate and test ESS data cabling, patch cord and patch panel.

G. Provide surge suppressor for all exterior mounted cameras.

H. Surge suppression shall be configured to protect video, power, and data wiring for exterior cameras.

I. Provide lightning protection for power, control and video cables for all exterior cameras. Seal and make watertight at all exterior cameras.

J. Provide and install an Uninterruptable Power Supply in the MDF room for server protection.

2.04 Basis of Design for Server and Storage

A. The school shall have a dedicated server and storage device(s) rack mounted within the MDF. Each server will have no more than 50 cameras assigned to the server. If a school has more than 50 cameras, the additional servers will be required.

B. Program all cameras initially to provide for recording and live viewing, 7 FPS, H.264 compression, 1.3 MB. , 50% motion to be archived locally for minimum of 30 days.

2.05 Network Communications

A. PoE network switches to be Owner-Provided and Owner-Installed.

B. Category 6 structured cable system to be provided under separate sections and provided by others.

PART 3 EXECUTION

3.01 Codes, Standards, Regulations

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials (ASTM)

1. ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire

2. ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. ASTM D 1557 (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

4. ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

C. Alliance for Telecommunications Industry Solutions (ATIS)

D. Building Industry Consulting Service International (BICSI)

1. Telecommunications Distribution Methods Manual 13th Edition

2. Outside Plant Design Reference Manual 5th Edition

3. ANSI/BICSI 002-2011, Data Center Design and Implementation Best Practices

4. NECA/BICSI 568-2006 – Standard for Installing Commercial Building Telecommunications Cabling

5. NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

E. Electronics Industry Alliance (EIA)

F. Federal Communications Commission (FCC)

1. FCC Part 15, Radiated Emissions Limits, revised 1998

2. FCC Part 68, Connection of Terminal Equipment to the Telephone Network, revised 1998

3. FCC Part 76, Cable Television Service, revised 1998

G. Insulated Cable Engineers Association (ICEA)

1. ICEA S-87-640 (2006) Fiber Optic Outside Plant Communications Cable

2. ICEA S-98-688 (2006) Broadband Twisted Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors

3. ICEA S-99-689 (2006) Broadband Twisted Pair Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors

H. International Electrotechnical Commission (IEC)

I. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. IEEE Standard 81-1983, IEEE Guide for Measuring Earth Resistance, Ground Impedance, and Earth Surface Potential of a Ground System

2. IEEE Standard 1100-1999, Recommended for practice for Powering and Grounding Sensitive

3. Electronic Equipment in Industrial and Commercial Power Systems (IEEE Emerald Book)

4. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code

5. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

J. International Organization for Standardization (ISO)

1. International Organization of Standardization/International Electrotechnical Commission (ISO/IEC)

2. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

3. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

4. ISO/IEC 11801, Information Technology-Generic Cabling for Customer Premises, 1995

5. ISO/IEC 14763-1, Information Technology-Implementation and Operation of Customer Premises Cabling-Administration, 1999

K. National Cable Television Association (NCTA)

L. National Electrical Manufacturers Association (NEMA)

1. NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits

M. National Fire Protection Association (NFPA)

1. NFPA-70, National Electrical Code
2. NFPA-75, Protection of Electronic Computer Data Processing Equipment.
3. NFPA-101, Life Safety Code
4. NFPA-297, Guide on Principles and Practices for Telecommunications Systems
5. NFPA-780, Standard for the Installation of Lightning Protection Systems.

N. National Institute Standards and Technology (NIST)

O. Occupational Safety and Health Administration (OSHA)

P. Telecommunications Industry Association (TIA)

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
3. ANSI/TIA -568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard, 2009
4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, 2008
5. ANSI/TIA/EIA–569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, 2005
6. ANSI/TIA–569-B Amendment 1, Commercial Building Standard for Telecommunications Pathways and Spaces, 2009
7. ANSI/TIA/EIA-606-B, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2012
8. ANSI/TIA/EIA-607-B, Commercial Building Grounding and Bonding Requirements for Telecommunications, 2011
9. ANSI/TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, 2004

Q. Underwriters Laboratories, Inc. (UL)

1. UL 510 (2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
2. UL 910 (NFPA 262 1990) Applicable Flame Test

3.02 In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify the Architect/Engineer in writing of any such occurrences before purchasing or installing any equipment or materials. The Architect/Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event

Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.

3.03 General Requirements

A. Contractor shall comply with the requirements of local Authority Having Jurisdiction (AHJ), State of Texas, the National Fire Protection Association (NFPA), and the National Electrical Code (NEC). If the Contractor identifies any item in the plans or specifications that will not strictly comply with the aforementioned laws, ordinances, and rules, the matter shall be referred to the Architect/Engineer for direction before proceeding with that part of the work.

B. The Contractor shall install the materials in accordance with these specifications and the manufacturer's installation guidelines.

C. No deviations from the plans or specifications shall be made without full consent in writing of the Architect/Engineer. The Contractor shall have written approval from the Architect/Engineer for any additional work beyond the Contract Documents prior to beginning such work. If the Contractor does not obtain written approval from the Architect/Engineer prior to proceeding with the work, the contractor shall not be reimbursed for the work.

D. The Contractor shall obtain written permission from the Architect/Engineer before proceeding with any work that would necessitate cutting into or through any part of the building structure such as, but not limited to girders, beams, floors, walls, roofs, or ceilings.

E. Contractor shall notify the Architect/Engineer a minimum of (2) weeks prior to beginning work and will participate in a pre-construction meeting with the Architect/Engineer to perform a walkthrough, review the scope of work, schedule, and escalation procedures.

F. The Contractor shall maintain a work area free of debris, trash, empty wire reels, scrap wire, etc., and dispose of such items on a daily basis and return the site to the original state of cleanliness. The Contractor shall not use Owner's facilities for the disposal of excess or scrap materials.

G. Equipment and materials installed by the Contractor shall be free of defects and damage.

H. Contractor shall be responsible for the repair of any damage caused by the contractor during the installation.

I. Contractor shall test all wires prior to installation. By failing to perform this testing operation, the Contractor shall accept the wire as compliant and assume all liability for the replacement of the wire at no cost to the Owner should it be found defective at a later date.

J. Contractor shall maintain a set of working specifications, design drawings, and shop drawings to be kept on site at all times and shall update the shop drawings on a weekly basis. Shop drawings shall be made available for inspection at the request of the Architect/Engineer.

K. Equipment and materials shall be consistent throughout the installation. Where multiple units of the same type of equipment and materials are required, these units shall be a standard product with the same manufacturer and model number.

L. Equipment and materials shall be delivered and stored in accordance with the manufacturer's guidelines at the Contractor's expense.

M. Contractor shall make all stored equipment and materials available for inspection at the request of the Architect/Engineer.

N. All equipment and material used in the installation shall be approved by the manufacturer for the environment in which it is being installed.

O. Wires shall be properly supported in accordance with industry standards at all times. Improperly supported wires shall be corrected by the Contractor at no cost to the Owner.

P. Contractor shall be responsible to properly protect wiring from damage by other trades during construction.

Q. Cables shall be routed at 90-degree angles to the building structure. At no time shall a diagonal pull be installed.

R. The Contractor shall not install wires in conduits or sleeves without nylon bushings. Wires installed through conduits or sleeves without nylon bushings shall be removed and replaced at no cost to the Owner.

S. The Contractor shall provide any lifts necessary to perform work.

3.04 System Requirements

A. Quantities listed are for reference only, contractor is responsible for furnishing materials as required to provide a complete and functioning system. Where quantities are not noted, they may be obtained from the drawings. In the event of a discrepancy between the specifications and the drawings, the greater quantity shall be furnished.

B. Electronic Surveillance System Software/Hardware

1. Electronic Surveillance Management System

a. Genetec/Omnicast (Latest Version)

1) Existing Genetec/Omnicast System and Contractor to provide an extension to the existing system.

2) Software Upgrade Plan (SUP) 1 year plan for XXX platform. .

3) The Contractor shall configure all associated electronic surveillance system software to include video viewing clients. Number and location of video viewing clients to be determined by Owner.

4) The Contractor shall provide installation in accordance with Manufacturer’s installation instructions.

5) The Contractor shall ensure communication is established between the electronic surveillance management system and installed surveillance cameras:

b. Electronic Surveillance System Licensing

1) The Contractor shall furnish and install.

a) NOT USED

2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

2. Electronic Surveillance System Server

a. Network Server

1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.

a) Dell R520 (with redundant power supply, RAID, 2x500GB O/S drives, 12x8TB storage drives, 8GB RAM, Windows Server 2012)

2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

3) The Contractor shall coordinate exact server location prior to installation.

4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.

5) The Contractor shall program all network address information for the network video recorder and ensure the server can communicate with other devices on the Owner's network

b. Two Post Rack Shelf

1) The Contractor shall furnish and install the following.

a) One (1) each Chatsworth 40751-719 Double Sided Steel Shelf in Two Post Rack located within MDF.

2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

3) The Contractor shall coordinate exact shelf location prior to installation.

C. Surveillance Cameras

1. Interior Camera

a. Fixed Dome

1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.

a) Axis P3354

2) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.

a) Axis P3384V

3) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

4) The Contractor shall coordinate exact camera location prior to installation.

5) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.

6) The Contractor shall program all network address information for the camera and ensure the camera can communicate with the electronic surveillance system server.

b. Fixed Dome

1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.

a) Axis P3364LVE

2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

3) The Contractor shall coordinate exact camera location prior to installation.

4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.

5) The Contractor shall program all network address information for the camera and ensure the camera can communicate with the electronic surveillance system server.

D. Power Equipment

1. Power Supply

a. 12 Volt DC

1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.

a) Altronix or approved equal.

2) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

3) The Contractor shall coordinate exact power supply location prior to installation.

4) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.

5) The Contractor shall be responsible for all low voltage terminations, high voltage power supply terminations will be provided by others (Div 26).

b. Surge Protection

1) The Contractor shall furnish and install the following.

a) Ditek as required
b) Atlantic Scientific as required

2) The Contractor shall provide surge protection on both the device side and at the switch.
3) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

c. Uninterruptible Power Supply

1) The Contractor shall furnish and install the following as indicated on the technology drawings and associated equipment schedules and diagrams.

a) APC Smart UPS

2) The Contractor shall provide an Uninterruptable Power Supply to supply at least 4 hours of continuous power and size accordingly.
3)
4) The Contractor shall provide installation in accordance with Manufacturer's installation instructions.

5) The Contractor shall coordinate exact uninterruptible power supply location prior to installation.

6) The Contractor shall energize and commission equipment in accordance with manufacturer's instructions and guidelines.

E. Pathway Cable Support

1. Communication room equipment racks/cabinets and Category 6 structured cable system are to be provided by others and this section is for information only.

a. All cables shall be installed and supported in conduit systems, cable trays, cores, sleeves, etc. as indicated in the technology drawings.

b. When cables leave the main pathway systems as indicated on the technology drawings, they shall be installed and supported in Contractor furnished and installed j-hooks or saddle straps.

c. No cable pathway shall exceed 40% fill ratio.

d. The contractor shall furnish a separate j-hook or saddle strap pathway for each wire type.

e. J-hooks and saddle straps shall be installed no more than five-feet (5') apart on center, using only manufacturer-approved installation methods and hardware.

f. J-hooks shall be furnished with closure clips.

g. Maximum sag between supports shall not exceed twelve-inches (12").

h. Contractor shall establish j-hook and saddle strap pathways and shall coordinate pathways with all other disciplines. Under no-circumstances shall these pathways be used to support other low-voltage applications not included in this specification.

i. Cable Dressing

1) No nylon cable ties shall be used at any time during the installation of the wire.

2) Above Ceiling

3) Contractor shall furnish and install plenum-rated hook & loop straps in plenum-rated airspaces.

a) The Contractor shall install no more than (1) hook & loop strap between each j-hook or saddle strap or at service loop locations.

j. Equipment Rooms / Telecommunications Rooms

1) The Contractor shall bundle all visible wires with Contractor furnished and installed hook & loop straps.

a) Hook & loop straps shall be installed twenty-four (24) inches apart on center.

F. Grounding and Bonding

1. General

a. The Contractor shall ensure metal-to-metal contact for all terminations.

b. All materials shall be UL Listed.

c. All connections shall be made with UL Listed compression 2-hole lugs.

d. Contractor shall use an anti-oxidation compound on all connections.

e. In a metal frame (structural steel) building, where the steel framework is readily accessible within or external to the room; each TMGB and TGB shall be bonded to the vertical steel metal frame using a minimum # 6 AWG plenum rated green insulated conductor.

f. A Grounding Equalizer conductor shall be installed when required by ANSI/TIA/EIA-607-B (Interconnects multiple TBBs on the top floor and every 3rd floor in between).

g. The connection to building steel does not eliminate the requirement for the TBB or EBC to the service ground.

G. System Labeling

1. Contractor shall verify room numbers and confirm the final room numbering scheme prior to generating any labels.

2. Cables shall be labeled within (12) inches from the termination point inside the Equipment Room/Telecommunications Rooms.

3. Cables shall be labeled within (6) inches from the termination point at the device end.

4. Cables shall be labeled identically at both ends.

5. Equipment Room/Telecommunications Rooms

   a. Contractor shall use the following room designations for wire labeling:

      1) MDF/IDF

6. Cable

   a. Electronic Surveillance System Cable

      1) Electronic Surveillance System cable labels shall contain the device number as indicated in the technology drawings, wire origin room number, wire destination room number, and wire type (i.e. C01/122-210/CAT6). In instances where no origin room number exists, utilize the device number as indicated in the technology drawings, wire destination room number, and wire type (i.e. C01/210/CAT6).

7. Equipment

   a. Electronic Surveillance System Devices

      1) Equipment to be labeled shall include but not be limited to cameras, network video recorders, video encoders, and media converters. Coordinate name, font style, and devices to be labeled with Owner or Owner’s representative before labeling. Provide computer generated labels, handwritten labels will not be accepted.

3.05 Testing Requirements

A. Electronic Surveillance System

1. The Contractor shall test and commission each component per the specifications and manufacture’s installation instructions.

2. Coordinate final network (ports, IP addresses, programming, etc.) requirements with Architect and Owner.

3. Test the Electronic Surveillance System devices, communication, and programming to ensure system components are functioning as intended.

4. A test report for each piece of equipment shall be prepared by the Contractor and submitted to the Owner. This report shall include a complete listing of every device,

the date it was tested, and the results. The final test reports shall indicate that every device tested successfully. Failure to completely test and document the testing will result in a delay of final testing and acceptance.

5. In the absence of a test by the manufacturer, use the operator's manual and demonstrates the ability to complete each of the functions listed.

6. Coordinate with the Owner to resolve any programming and communication problems that occurred during the test.

7. The Security Consultant will prepare a punch list of items identified during the test that require correction before final acceptance.

8. Upon completion of testing and coordination, the Owner and the Security Consultant will conduct a final acceptance test.

B. Grounding and Bonding

1. Main Building Ground

a. Coordinate with electrical contractor and provide a copy of their test results for the main building ground. The results shall be below 25 Ohms.

2. Two-Point Ground/Continuity Testing

a. Prior to the two-point ground testing, a visual inspection shall be performed to verify that the bonding and grounding system is installed according to the drawings and specifications and in compliance with the TIA-607-B Standard.

b. All testing shall be conducted prior to any active equipment is installed.

c. The Contractor shall use an earth ground resistance tester that is configured for a continuity test. This is also known as a two-point tester or a "dead earth" test.

d. Prior to the two-point continuity test conduct a voltage test to ensure there is no stray voltage in the system.

e. The testing shall include but is not limited to the following points.

1) Building electrical grounding electrode and the TMGB.

2) TMGB/TGB to electrical ground in ER/TR.

3) TMGB/TGB to the building steel (if present).

4) TMGB to each TGB.

5) Building steel (if present) to the electrical ground.

f. Per the TIA-607-B, the maximum value for resistance between any point in the telecommunications bonding and grounding system and the building's electrical grounding electrode system is 100 milliohms. In the case of long TBB and Grounding Equalizer conductor runs, the resistance of the conductor must be factored into the total resistance. For example 1 km of a No. 3/0 conductor has a resistance of 0.2028 ohms. (0.06180 ohms per 1000 ft.)

The Contractor shall notify the Architect/Engineer a minimum of five (5) days in advance to observe field testing

3.06 Training Requirements

A. Electronic Surveillance System

1. Coordinate with the Owner to establish a training outline and schedule. Submit a comprehensive training curriculum to the Owner once all preliminary coordination is complete. The Owner will revise and comment on the curriculum as required.

2. Provide a minimum of 2 hours of operator training, and 2 hours of administrative training, either on or off site on a complete and fully operational system parallel and equal to the system being provided, to representatives of the Owner.

3. Operator training shall include, but not be limited to the following:

1) GUI operation

2) Manual and automatic camera call-up procedures

3) Video motion detection functionality

4) Electronic Surveillance System recording playback functionality

4. Administrator training shall include, but not be limited to the following:

1) GUI operation and configuration variables

2) Manual and automatic camera call-up procedures (including macro sequence assignment)

3) Video motion detection setup, configuration variables, and functionality

4) Recoding setup, configuration variables, and functionality

5) Electronic Surveillance System recording playback/export functionality

5. Record, label, and catalog all training on DVD. Provide the DVD to the Owner for future in-house training sessions and / or reviews. Furnish all temporary equipment necessary for recording all training sessions. Maintain accurate and up-to-date time sheets of all training sessions.

6. The Contractor shall be on call during the Warranty to answer any questions the Owner might have. The Owner reserves the right to use any excess training hours, not used by the time of system completion, for future training as requested by the Owner until the total number of training hours has been completed.

3.07 Project Closeout Documentation

A. As-Built Drawings

1. Drawings shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until drawings are received and approved by the Architect/Engineer.

2. Three (3) sets of drawings depicting the condition of the electronic surveillance system as installed.

3. As-Built drawings shall be produced in AutoCAD 2010 or higher and provided in hardcopy and electronically in .dwg and PDF format.

4. Hardcopy drawings shall be provided in the original size as issued by the Architect/Engineer.

5. Drawings shall retain the formatting and title block of the original drawings as issued by the Architect/Engineer.

6. Drawings shall be provided utilizing the original scale and shall include the exact dimensions and locations of all equipment room/telecommunication room layouts, wall elevations, equipment rack elevations, ladder racks, cable tray, sleeves, pathways, card reader locations and labeling scheme.

B. Test Documentation

1. Test documentation shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until these test results are received and approved by the Architect/Engineer.

2. Three (3) sets of test documentation for the electronic surveillance system as installed.

3. Test results shall be provided in hard copy and electronic format (i.e., manufacturer's proprietary testing software along with Contractor's test records).

4. Test documentation shall be bound, sectioned, and tabbed in the following sequence as applicable:

   a. Electronic Surveillance System

   b. Electronic Surveillance System Wiring

C. Contactor's Statement of Warranty

1. Statement of warranty shall be provided to the Architect/Engineer at the time of substantial completion. Final payment will not be recommended until statement of warranty is received and approved by the Architect/Engineer.

2. Contractor shall furnish a minimum of a one (1) year warranty on all materials, labor and workmanship starting at final system acceptance.

3. One original and two copies of Contractor's warranty terms and conditions to include contact information (i.e. Contractor name, Point of Contact, address, phone number and email address) and start and end date for warranty call outs.

Attachment “A”

Provide an itemized listing of all equipment and material required to meet the specifications for the Electronic Surveillance System. This listing shall include Part Number, Description, Unit of Measure, Unit Cost, Quantity, Labor Cost, and Extended Cost.

Part Number	Description	Unit of Measure	Unit Cost	Quantity	Labor Cost	Extended Cost

Total Equipment and Materials	$ -
Total Labor and Installation	$ -
Grand Total	$ -

Attachment "B"

Provide an estimated drop count for each Equipment Room/Telecommunications Room indicating the quantity of wires served from each applicable Equipment Room/Telecommunications Room.

Equipment Room/Telecommunications Room	Category 6 4-Pair UTP	Multi-Conductor Data Cable	Multi-Conductor Power Cable
Total			

END OF SECTION

SECTION 28 31 00 – FIRE ALARM AND SMOKE DETECTION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements for furnishing and commissioning a fully functional addressable fire alarm and voice evacuation system with full interface with other related systems. Work shall include, but not limited to, the following.

1. Fire alarm control and annunciator panels
2. Manual fire alarm stations
3. Automatic fire, smoke, and heat detection devices
4. Audible and visual alarm notification devices
5. Required batteries, battery panels, and associated accessories
6. Fire door control, security door control
7. Air handler duct smoke detection, and shutdown
8. Sprinkler system PIVs, OS&Y valves, and tamper switch monitoring
9. Sprinkler systems water flow and/or pressure switch monitoring
10. Monitoring of fire pump controls
11. Fire/smoke damper control
12. Smoke purge controls
13. Activation of deluge and pre-action sprinkler systems
14. Elevator recall and power shutdown
15. System acceptance testing and commissioning
16. Firefighters' two-way voice communication system

1.2 REFERENCES

A. NFPA 101 - Safety to Life from Fire in Buildings and Structures

B. NFPA 13 - Installation of Sprinkler Systems

C. NFPA 20 – Installation of Stationary Pumps

D. NFPA 70 - National Electric Code

E. NFPA 72 - National Fire Alarm Code

F. NFPA 90A – Installation of Air-Conditioning and Ventilating Systems

G. NFPA 92A – Smoke- Control Systems

H. UL 864 - Control Units for Fire Protective Signaling Systems

I. ADA Accessibility Guidelines (ADAAG)

J. Texas State Insurance Code

K. Texas Accessibility Standards (TAS)

L. Local-city Ordinances

M. International Building Code

N. All electronic equipment shall comply with all FCC limits governing radio frequency electromagnetic interference and be so labeled.

O. None of the terms or provisions of this specification shall be constructed as waiving any of the rules, regulations or requirements of Codes.

1.3 SYSTEM DESCRIPTION

A. The automatic fire detection and alarm system shall consist of a main fire alarm control panel, local control panel nodes, operator workstation, graphics terminal, audio control panel, printer, remote annunciator, detection devices, audible and visual notification devices, remote devices, and manual stations wired in accordance with the schedule on the Drawings and shall function as specified herein. The system shall use supervised multiplex data communications circuits, close loop initiation circuits, individual zone supervision, and individual audible and visual alarm circuit supervision.

B. The system shall have sufficient capacity to incorporate all equipment and perform all functions as per intent of the specifications and Drawings. The system shall have an overall 20 percent spare capacity that includes but not limited to communication network, terminal strips, amplifier, batteries, etc., reserved for future expansion.

C. The system shall be capable of being programmed on site for downloading, uploading or editing operating sequence or programming to accommodate and facilitate building parameter changes or changes as required by codes.

D. A data communications network transmitting multiplexed input and output signals, which shall be electronically supervised, shall connect all control panel nodes. The communication network shall consist of a communication cable transmitting all system operations in a digitally encoded format, an audible signaling bus serving all remote amplifiers, and a two-way phone communications bus serving all individually controlled fire phone circuits.

E. The fire alarm control panels shall provide power, annunciation, supervision, and control for the fire detection and alarm system. Fire alarm control panels shall be distributed per floor or per zone as practical, such that each fire alarm control panel shall operate as a local stand-alone system with communication network connection to peers and main fire alarm control panel that normally resides in Fire Command Center. The Main Fire Control Panel in Fire Command Center

shall monitor and annunciate all alarms and troubles of each Fire Alarm Control Panel in the fire alarm network system scattered throughout the building. All data communication wiring between the controls panels shall be supervised for open circuit, short circuit and ground fault.

F. Data communication transmission shall use a peer-to-peer network communication channel with token-ring communication protocol as follows.

1. Each node shall communicate to the next node in a peer-to-peer token-ring configuration.

2. In the event that the path to the next node on the ring has experienced a communication failure, the node with possession of the token shall transmit it back in the direction from which it came to attempt to reach the next node by going around the ring in the opposite direction. At the same time the status of non-communication node shall be added into the content of transmission.

3. In the event of communication break down and a group of nodes become isolated from the network, that group shall form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.

4. In the event that a single node becomes unable to handle the network token, the network interface card shall continue communications to the rest of the network. The off-line node is reported as such to the network and is periodically interrogated to determine if it is ready to be brought back online with the rest of the network.

G. Fire detection initiation devices and audible visual alarm devices shall be wired to the fire alarm control panel on the same floor or with the same zone as practical. Smoke or heat alarm initiation devices shall be individually configurable on site to function desirable selective alarm, general alarm, evacuation, alert, test, fire/smoke damper operation, fire door/security door release, smoke control operation, HVAC interface or trouble warning.

H. The system shall be designed such that alarm indications override trouble conditions. There shall be no limit, other than maximum system capacity, as to the number of addressable devices and/or zones, which may be in alarm simultaneously. The panel shall be capable of measuring the sensitivity of the addressable ionization and photoelectric detectors connected to it.

I. The system shall initiate the following system outputs when any area or duct detector, manual station, or water flow switch operates in accordance with the fire alarm functional matrix:

1. Audible devices - speakers.

2. Visual devices – strobes and/or beacons.

3. Automatically notify fire department, central station, and/or command center.

4. Display individual detector and/or zone number on alphanumeric display with optional user-defined message.

5. Light an indicating lamp on the device initiating the alarm.

6. Shut down the associated HVAC system and operate dampers per drawing.

7. Activate the elevator recall.

8. Release all magnetic fire door holders.

9. Activate deluge or pre-action sprinklers.

J. The fire alarm and smoke detection system shall be used to monitor tamper switches and water flow switches on sprinkler and fire suppression systems.

K. Fire alarm and smoke detection system shall release fire doors that are held open and security access controlled doors that are held close if desired.

L. Fire pumps shall be monitored by the fire alarm and smoke detection system.

M. Fire alarm and smoke detection system shall include the installation of duct-mounted smoke detectors, interface with HVAC damper control, and air-handler shutdown.

N. Type and quantity of signals, which are expected to be transferred and monitored by existing campus command/dispatch center, shall be verified during design phase. Compatibility issue also needs to be addressed.

O. Provide all modules and interfacing necessary for implementation of mass notification system.

P. Provide all interfacing to generate the alarm and activate the proper alarm output to the building speakers, strobes etc.

Q. Design speaker placement to ensure intelligibility of speech (as defined by NFPA 72 Year 2010) throughout the building and per current codes and regulations.

R. Provide system interface with campus Building Automation System BAS.

1.4 QUALITY ASSURANCE

A. The system shall be installed by competent mechanics, regularly employed by a Fire Alarm contractor with full responsibility for proper operation of the system including debugging and proper calibration of each component in the entire system. The Contractor shall be with 3 years or more experience with installation of this type. The fire alarm technician shall be licensed by State Fire Marshal in order to install, certify and service the fire alarm system. Supplier shall be licensed by State Fire Marshal in order to sell fire alarm product, and shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

B. The complete Fire Alarm and Smoke Detection System installation shall be in strict accordance to the national and local electrical codes and the electrical Section of these specifications. The equipment shall be manufactured by a manufacturer who has been engaged in this type of production (both hardware and software) for at least ten years. The product shall be UL listed under standards 864 (Control Units for Fire Protective Signaling Systems).

1.5 SUBMITTALS

1. The contractor shall include the following information in the equipment submittal:

   a. Power calculations.

      1) Battery capacity calculations. Battery size shall be a minimum of 150% of the calculated requirement.

2) Supervisory power requirements for all equipment.

3) Alarm power requirements for all equipment.

4) Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition.

5) Justification showing power requirements of the system amplifiers.

6) Voltage drop calculations for wiring runs demonstrating worst case condition.

b. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

c. Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product suitability. At a minimum, data shall be submitted on the following:

1) Master system CPU including all fire detection, voice/audio and visual evacuation alarm control modules, and supervised power amplifiers with the required back up modules.

2) Circuit interface panels including all modules.

3) Power supplies, batteries and battery chargers.

4) Pre-amplifiers, amplifiers, tone generators, master microphone and master telephone.

5) Equipment enclosures, including dimensions and weights of completed units.

6) Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, and supervised control modules.

7) Annunciator panel and printer.

8) Audible and visual evacuation signals and devices.

9) Software and firmware as required to provide a complete functioning system.

10) Circuiting, including conduit and wire sizes.

d. Data describing more than one type of item shall be clearly marked to indicate the type the contractor intends to provide for options not crossed out in submittal material will be furnished for the project. All submittal material shall be complete. Partial submittal will not be evaluated and will be rejected without comment. The contractor shall submit copies of UL listing or FM approval data showing compatibility of the proposed device or appliance and the panel being provided.

e. Complete drawings covering the following shall be submitted by the contractor for the proposed system:

1) Floor plans showing all communicating, initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, message digitizers, amplifiers, annunciators, printers, video display terminals, color graphic displays, transponders and the main CPU locations. Raceways shall be shown, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Drawings shall indicate ambient sound levels used by the system installer for sound level calculations and mathematical justification for signal placement to meet the code required 15dBA above ambient for audible warning signals.

2) Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.

f. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a 3.5" high density floppy disk or CD ROM and in a formatted printed form, as required for off site editing, uploading and downloading shall be submitted for evaluation by the owner. A programming manual shall accompany the submitted program and shall be adequate to allow understanding, operation and editing by the system owner.

g. Statements shall be included, with copies of required licensing, verifying the qualifications of the installer as specified.

h. The fire alarm system subcontractor or manufacturer shall offer, for the owner’s consideration at the time of system submittal, a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.

2. For use in system test, a complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.

a. The following information shall be inscribed on the cover:

1) "OPERATION AND MAINTENANCE MANUAL"

2) Building location.

3) The name of the contractor, system manufacturer and system subcontractor.

4) The name and phone number of the fire department required to respond to alarms at the project location.

b. The manual shall be legible and easily read with large drawings folded and contained in pockets. Included in the manual shall be circuit drawings, wiring and control diagrams with data to explain detailed operation and control of each item of equipment and a control sequence describing start up instructions. Included shall be installation instructions, maintenance instructions, safety precautions, test procedures, performance data, and software documentation.

3. Upon completion of the installation, record drawings shall be submitted on each system before final acceptance of the work. The contractor shall furnish to the Owner a set of record drawings including system diagrams for each system. The record drawings masters shall be on reproducible mylar film, uniformly sized as required for legibility and reproduction and on high density floppy disks or CD ROM in an AutoCAD DXF format.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver fire alarm system components in factory-fabricated containers.

B. Store in a clean, dry space and protected from the weather.

C. Handle control and annunciator panels carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Simplex

B. Edwards

C. Siemens Fire Systems (cerberus Pyrotonics) type MXL

D. Other manufacturers equal in design and function will be consid¬ered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

E. Manufacturers listed above must comply with entirety of specification and must be compatible with any existing campus fire alarm systems and must comply with any and all campus standards.

2.2 FIRE COMMAND CENTER OPERATOR WORKSTATION

A. Operator Workstation Hardware

1. The operator workstation personal computer shall be a central network processing unit providing alarm signals, annunciation, status display, software programming and controls for network functions using a Windows based graphic interface with a high resolution, touch-screen or mouse operated color monitor. The PC workstation shall provide control up to 50,000 points allowing future expansion without hardware additions.

2. The operator workstation shall provide color graphic-based display of alarms, troubles, and system activity. Terminal shall provide complete operator control over fire alarm system, including acknowledging events, silencing audible alarms, reset control panels, disarming points, and generating alarm reports and diagnostic reports. Terminal shall be UL listed for fire alarm use.

    a. Computer: minimum Pentium III, 800MHz, 128 Mb RAM, 20 Gb hard disk.

    b. Interface: touch-screen or mouse operated.

    c. Monitor: 15 inch SVGA monitor.

    d. Operating system: Microsoft Windows NT.

    e. Password protection: 10 levels of password protection.

    f. Drawing input: AutoCAD drawing imported.

g. Screen library: 5,000 custom screen capacities.

h. Zoom levels: 32 zoom levels per drawing.

i. Historical logging: 20,000 events minimum.

j. Fire alarm interface: RS-232 or RS-485

k. Network interface: Ethernet network card included.

l. Printer connection: two RS-232 ports, minimum.

m. System power: 120 Vac, 60 Hz, and single phase with integral UPS capable for 4-hour operation.

n. Clock: Real time clock.

o. Calendar: Electronic appointment calendar, with auto alarm.

p. Calculator: Basic arithmetic calculation functions (add, subtract, multiply, divide, percent, square root)

q. Control panel: Basic PC operating characteristic control; cursor blink rate, mouse sensitivity, screen color control, etc.

r. Note pad: Archive for miscellaneous notes.

3. The system provided must be capable of running standard off-the-shelf MS DOS compatible software packages concurrently with the real time system. Fully tested and qualified integrated third party software packages including spreadsheet, data base manager, and word processing shall be provided capable of running under MS DOS is to be identified as system compatible and listed in the submittal.

a. The base system software shall include a CRT "windowing" feature to allow the operator to monitor the real time system and use third party software simultaneously.

b. All third party software packages identified shall have access to the system historical database previously specified.

B. Operator Workstation Software

1. Operator workstation software shall include as a minimum the Operating System (OS), Database Manager, Communications Control, Operator Interface (OI), Trend and History Files, Report Generator, Support Utilities, Scheduler, Time and Event Programs.

2. Real time operating system shall provide true multitasking providing concurrent execution of multiple real time programs and custom program development.

3. Database manager is to manage all data on an integrated and non-redundant basis. It shall allow additions and deletions to the database without any detriment to the existing data.

Cross linkages are to be provided such that no data required by a software program may be deleted by the operator until that data has been deleted from its respective program.

4. Communications control, scheduler, trend files, reports, operator interface, and utilities shall be as specified hereinafter.

5. Provide a hierarchical linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. The interface shall utilize the mouse to provide "heads up operation" with pull-down menus, dialog boxes, zoom, coloration and animation to facilitate operator understanding of the system. A minimum of twenty (20) levels of graphic penetration shall be provided with the hierarchy operator assignable (for example, area, building, wing, floor, and sequence of operation pages, dynamic program display, and I/O point group). Dynamic system data points shall be assignable to each penetration level. Descriptors for graphics, points, alarms, etc. shall be modified through the operator's station under password control.

6. Operator access to the system is to be under personal ID and password control for up to 100 unique operators. Up to 12 alphanumeric characters for personal ID and up to 12 alphanumeric characters for password shall be assignable to each operator via the operator station. The operator shall be able to access the system from any operator station in the system by entry of the proper ID and password. The operators shall be permitted to change their own password without permitting access to any other password. Sign-off from a station shall be a manual operation via pull-down menu or, if no mouse or keyboard activity takes place within an assignable time period, shall be automatic. Automatic sign-off period shall be selectable from ten minutes to 120 minutes for each operator or may be disabled on a per operator basis. All sign-on/sign-off activity shall be automatically archived on the operator station disk for subsequent display or printout as desired.

7. Operator access to system points shall be controlled by individual operator-assigned graphic hierarchy and by privileges. The hierarchy shall permit access to an operator-assigned initial graphic and to all graphics linked to and below the initial graphic. The operator shall not have access to graphics in another hierarchical graphic "tree".

8. Data to be displayed within a unique graphic shall be assignable regardless of physical hardware address, communication channel or point type. Graphics are to be on-line programmable and under ID and password control. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation and where specified. Graphics shall also contain calculated or pseudo points. Each physical point and each point assigned to a graphic shall be assigned a descriptor for use in reports.

9. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding. The "back trace" shall permit the operator to move upward in the hierarchy by mouse click on the back trace. The back trace shall show at least the previous four penetration levels. The operator shall be provided the option of showing each graphic full screen size with the back trace as the horizontal header or by showing a "stack" of graphics, each with a back trace.

10. All operator accessible data shall be displayed on the color monitor. The operator shall select further penetration via mouse click on an area, building, floor, etc. The defined linked graphic below that selection shall then be displayed. Dynamic data shall be assignable to any and all graphics.

11. The operator shall be provided with a means to directly access any graphic or any point without going through the penetration path.

12. Direct access to graphics shall be menu selectable wherein the operator may optionally enter the name of the graphic system desired or select the desired graphic via cursor positioning on a scroll bar listing of all graphics, or may be selected via keyboard entry.

13. Points (physical and pseudo) shall be displayed with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit. Coloration shall be used to denote status and alarm states. Coloration conventions shall be variable for each class of points, as chosen by the owner. In addition, animation shall be used to confirm latest status. All points shall be dynamic with update rates user adjustable on a per point basis from 20 seconds to 120 seconds, depending upon the process dynamics.

14. An operator shall be permitted to split or resize the viewing screen to show one graphic on the left half of the screen and another graphic, spreadsheet, bar chart, word processing, curve plot, etc., on the right half screen. This will allow real time monitoring of one part of the system while displaying other parts of the system or data from the system to facilitate system operation.

15. An on-line context-sensitive "help" utility shall be provided to facilitate operator training and understanding. The help feature shall be a hypertext document with the ability to bridge to further explanation of selected keywords. The document shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every menu item and dialog box. If the help utility does not have this ability to bridge on keywords for more information, four complete sets of user manuals shall be provided with quarterly updates and additional training as hereinafter described.

C. Site Specific Fire Alarm Software

1. Provide software that will allow the user to modify and tailor the Fire Alarm System to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices. On-line modification of system configuration, program parameters, and database shall be provided via menu selection and keyboard entry of data into preformatted self-prompting templates. As a minimum, the following modification capability shall be provided.

   a. Operator assignment capability shall include designation of operator ID, passwords, privilege(s), starting graphic and auto sign off duration.

   b. Peripheral assignment capability shall include assignment of segregation groups to consoles and printers, and designation of backup printers.

   c. System configuration/diagnostic capability shall include communications and peripheral port assignments, assignment of command trace to points and initiation of diagnostics.

   d. System text add/change capability shall include action messages for alarms, supervisory, and trouble condition messages.

   e. Time/Schedule change capability shall include time/date set, time/occupancy schedules, holiday schedules, and daylight savings time schedules. All time and calendar scheduling and schedule modification shall be accomplished graphically via color bars and calendars in a hardware independent manner.

   f. Points shall be uniquely definable as to coloration, animation, audible rate and duration, point descriptors, operator messages (480 characters minimum), printer options, alarm archival option, alarm and warning limits, and engineering units. All

messages specified and all physical and pseudo point descriptors shall be entered by the vendor.

g. Point related change capability shall include system/point enable/disable; assignment of points to point classes, analog value offset, and setting a fixed input value or output status.

2. Graphic creation. An on-line graphic development facility shall be provided to allow the user to develop or modify graphic displays and assign and position any array of points within each graphic.

a. All graphic displays shall be on-line created via operator station graphics package. It shall not require taking the operator station off-line or interfere with point archiving and alarms. Graphics shall be created via mouse and keyboard selection of graphic library stored symbols and system profiles. Provide, in addition, the capability to create custom symbols, system profiles, floor plans, buildings, etc., and to store them in the graphic library.

D. Alarm handler software shall be provided to respond to alarm conditions sensed and transmitted from fire alarm control panels. First in, first out handling of alarms in accordance with alarm priority ranking is required in case of simultaneous multiple alarms. There shall be no limitation of handling the amount of alarms, which may be activated simultaneously. Alarm handler shall be active in both the Signed On and Signed Off modes to assure that alarms will be processed even though an operator is not currently signed on.

1. Alarms shall be displayed in a dialog box of the color monitor. Display shall include as a minimum:

a. Indication of alarm condition; i.e., ABNORMAL OFF, HI ALARM/LO ALARM, analog value or status, point identification.

2. Alarms are to be directed to appropriate operators, operator stations, and printers for segregation assignments as specified in previous Sections of this specification.

3. Alarm silence shall be by selecting the "silence" button or by authorized operator's acknowledgment. In all cases, alarm acknowledgment shall only be allowed by operators authorized to acknowledge a point in alarm.

4. Each point shall be assigned to an alarm class, with no limit to the quantity of alarm classes. Each alarm class shall be uniquely assignable to any combination of the following alarm processing attributes:

a. Audible beep duration (none, 10 seconds, 20 seconds, continuous)

b. Audible beep rate (slow-medium-fast)

c. Alarm historically archived (yes or no)

d. Alarm printed, with printer ID

e. Associated coloration with any of 256 colors, with separate brightness control, assignable to each alarm state (high alarm, high warning, normal, low warning, low alarm). Digital points shall similarly be distinguished with different colors for each possible state.

5. Alarms shall be displayed and/or printed at each peripheral to which its segregation allows, but only those operators having proper privilege level will be allowed to acknowledge alarms.

6. An unacknowledged alarm indicator shall be provided on the color monitor display to alert the operator that there are unacknowledged alarms in the system.

7. Symbols for points in a graphic display that are in an unacknowledged alarm state shall flash red; when in an acknowledged state, the symbol shall be non-flashing-red.

8. Run time limit messages shall be presented and processed as alarm messages except the action message shall be of a maintenance directive nature.

E. Standard reports shall be provided, which shall be operator selectable to appear on the operator station, any selected printer or both. A "terminate report" command shall be available to allow the operator to stop any report in the process of being printed. In the event of failure of any printer, subsequent reports directed to that printer shall be automatically redirected to an operator pre-assigned backup printer located at the operator station. The following standard pre-formatted reports to be provided shall include:

1. Point summary reports may be requested at any penetration level (facility, building, area, system) and shall include only points at and below that level. Point summary reports shall include the current value/status and condition, system and point descriptors for all points. Point summary reports shall be selectable for all points, only those points in alarm, fixed points, disabled points locked out points, locked out and in alarm points, analog input or output points, digital input or output points. All reports shall be capable of being scheduled to run at a specific time and/or interval via an operator function supported by necessary data entry templates and interactive prompts.

2. Dynamic trends shall provide up to six points and show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by the operator. Graphic plots shall allow a unique color for each point. As new point values are sampled, they shall be processed, scaled, and dynamically appended to any plot being displayed. Sample interval of points selected for dynamic trend shall be user selectable from five seconds to sixty minutes.

3. Alarm and run time reports shall be automatically issued to assigned printers immediately upon occurrence, and shall consist of the point descriptor, the status or value of the point with engineering unit, the time and date, and an action taking alarm message.

4. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of all commands issued to each point. The archived trace shall include the command, the command source, the point ID, and the time and date. Command trace reports shall be output upon operator demand.

5. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only. Custom reports may be scheduled or requested manually. A spreadsheet program similar to Microsoft Excel shall be provided fully integrated with the Fire Alarm System data base, and available to the user. Spreadsheet packages that require off-line execution or manual translation of data files from one program format to another are not acceptable.

F. Digital System Management. The operator workstation shall provide complete utilities necessary for management of the network of digital controllers and devices.

1. Provide a multi-page set of dynamic graphic architectural displays showing each digital module including each remote panel, PC, peripheral, and communication links. Clicking on any device shall start an interactive dialog allowing the user to observe the device status and to select device management options. Each device shall also be provided with a descriptor. Digital devices in a failed or non-responsive mode shall show up distinctly red in digital system graphics.

G. The software shall be designed specifically for fire alarm applications and shall provide for polling and demand requests to monitor status; processing alarms according to priorities; executing event-initiating programs; controlling/processing communications with operator peripherals; and synchronizing all systems activity. For reasons of reliability and preventing inadvertent changes, system software (operating system and data file) shall be maintained in non-volatile memory. System shall permit reprogramming by authorized personnel.

2.3 FIRE ALARM CONTROL PANELS

A. Control panel enclosure shall consist of a floor-standing or surface-mounted back-box, hinged door, keyed lock, and tamper switch. Tamper switch shall put control panel into a trouble mode when door is opened. Back-box shall be sized to accommodate batteries, battery charger, power supply, control panel, indicating, initiating, communications, relays, and switch modules.

B. The control panel power connections (whether ac or dc) shall be separately fused within the control panel. The system power supply shall be provided with an integral uninterruptible power source (UPS). This UPS shall provide continuous power to the system in the event of a commercial power failure. Transfer from commercial power shall be instantaneous to ensure proper processor operation and indicated by flashing the system power long-life light-emitting diode (LED).

1. Loss of commercial power shall be annunciated as a system trouble. System trouble shall be indicated for over-voltage or under-voltage conditions, blown fuses, or disconnected batteries.

2. The system shall visually and audibly indicate operation from standby power. The system shall automatically restart upon the return of power. No operator intervention shall be required.

3. A dual-rate battery charger shall be provided, which is capable of recharging the batteries to 80 percent capacity in 12 hours.

4. Batteries shall be sized to provide 24 hours of standby operation followed by 5 minutes of operation of alarm notification appliances and 15 minutes of voice/alarm communication [mass notification] systems.

C. The control panel shall be modular with solid-state electronics and microprocessor. The control panel shall provide power, annunciation, supervision, and control for the detection and alarm system. The system shall be capable of reading and displaying at the control panel the sensitivity of remote addressable ionization and photoelectric detection devices. The detection system shall remain 100 percent operational and capable of responding to an alarm condition while in the routine maintenance mode. Addressable detection devices shall be individually identified by the system, and any quantity of addressable detection devices shall be in alarm at any time up to the total number connected to the system.

1. The control panel shall be capable of supporting addressable detection devices.

2. The panel annunciator shall be an alphanumeric display, which shall provide an optional user-definable message associated with each detection device or zone.

3. Dynamic supervision of system electronics, wiring, detection devices, and software shall be provided by the control system. Failure of system hardware or wiring shall be indicated by type and location on the alphanumeric annunciator. The system shall provide fail-safe operation, i.e., incoming alarms shall automatically override all other modes of operation, and the panel shall automatically return to normal operating mode from any operator-initiated mode.

4. Ground fault detection shall be provided for all initiating and audible circuits. Lamp test capability shall be provided to test all visual panel indicators and associated software.

5. The system alarm lamp shall flash and an integral trouble buzzer shall sound upon receipt of any alarm condition. Acknowledgment of the alarm by operation of the silence switch shall silence the audible alarm and cause the alarm lamp to light steadily. Receipt of subsequent alarms shall cause the alarm buzzer to resound and the alarm lamp to flash.

6. The system trouble lamp shall flash and an integral trouble buzzer shall sound upon the occurrence of any trouble condition. Acknowledgment of the trouble condition by operation of the silence switch shall silence the audible alarm and cause the trouble lamp to light steadily. Receipt of subsequent troubles shall cause the trouble buzzer to resound and the trouble lamp to flash.

7. The service mode shall permit the arming and disarming of individual detection or output devices, as well as manually operating output devices. Status of these devices shall be displayed upon command from the control panel. The panel shall automatically return to normal mode in the event the panel remains unattended in the service mode. The panel shall be capable of receiving and processing alarms even when in the service mode.

8. The control panel shall report, by specific device number, any device removed from an addressable initiating circuit, and all other devices shall continue to function.

9. The control panel shall have the ability to support an optional printer terminal.

10. No alarm or trouble indication shall be resettable until it has been acknowledged. It shall not be possible to reset the system until all alarms have been acknowledged and devices cleared.

11. The control panel shall have the ability to support a drill function on the panel that is easily identifiable and only initiates notification appliances on all floors.

12. Each panel shall have the following capacity:

    a. Sensor Points: 275 addressable analog sensor points.

    b. Module Points: 275 addressable monitoring and control module points, including 50 points as follows:

        1) Onboard Strobe Circuits: 10 circuits rated for 2 amps each at 24 Vdc.

        2) Onboard Speaker Circuits: 10 circuits rated for 25 watts each at 70.7 VRMS.

        3) Onboard Telephone Circuits: 10 fireman's telephone circuits.

4) Onboard Auxiliary Relay Circuits: 10 general input circuits, 10 general output circuits.

c. Amplification: 500 watts, 70.7 VRMS, distributed, with one 500 watt backup amplifier every three panels.

d. Audio Channels: two.

e. Power Supply: 20 amps, 24 Vdc.

f. Battery Backup: 140 ampere-hour backups at 24 Vdc.

g. Mounting: NEMA 12 wall- or floor-mounted enclosure.

h. System Power: 120 Vac, 60 Hz, and single phase.

13. The following primary controls shall be visible through a front control panel.

a. 80-character liquid crystal display.

b. Individual red fire alarm LED.

c. Individual red priority 2 alarms LED.

d. Individual yellow supervisory service LED.

e. Individual yellow trouble LED.

f. Green “power on” LED.

g. Yellow signals silenced LED.

h. Fire alarm acknowledge key.

i. Priority 2 alarm acknowledge key.

j. Supervisory service acknowledge key.

k. Trouble acknowledge key.

l. Alarm silence key.

m. System reset key.

n. Speaker circuit selection switches with LEDs.

o. Master audio control microphone.

p. Master fire fighters phone.

q. Phone circuit selection switches with LEDs.

14. The following functions shall be provided by operating the front control panel.

a. LED testing.

b. Alarm, trouble, and abnormal condition listing.

c. Enabling and disabling of each monitor point separately.

d. Activation and deactivation of each control point separately.

e. One-person test/drill enable.

f. Running self-diagnostic.

g. Display historic logs.

h. Point listing.

15. Scrolling through menu options or lists shall be accomplished in a self-directing manner in which prompting messages shall direct the user. These controls shall be located behind an access door.

16. Under normal conditions the front display panel shall display a “System Normal” message and the current time and date. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for supervisory and trouble conditions. The LCD shall display the following information relative to the abnormal condition of a point in the system.

    a. 40 character custom location label

    b. Type of device (i.e., smoke, pull station, water flow)

    c. Point status (i.e., alarm, trouble)

D. Fire alarm audio control panel shall provide complete voice annunciation control of the fire alarm system. Panel shall include ability to select paging zone by area or all call. Panel shall include master fireman's telephone handset, and interface shall be integral to panel. Panel shall support both live paging and prerecorded digital messages. Performance:

1. Audio Channels: two simultaneous 70.7 VRMS channels, minimum.

2. Phone Risers: two fireman's telephone risers, minimum.

3. Audio Levels: VU meter for audio level monitoring.

4. Digital Message Length: 10 messages, 30 seconds each, minimum.

5. Preamp Supervision and Automatic Changeover: yes.

6. Amplification: supports 10 distributed- or central bank amplifiers.

7. Backup Amplification: supports four backup amplifiers.

8. Degrade Mode: degrade mode reverts to tone generation.

9. Mounting: NEMA 12 wall- or floor-mounted enclosure.

10. System Power: 120 Vac, 60 Hz, single phase.

E. Line printer shall provide hard copy written record of alarms, troubles, and system activity. Printer shall be UL listed for fire alarm use. Performance:

1. Serial or parallel printer.

2. 24 pin, dot matrix, wide-carriage type.

3. Paper out, offline, paper jam, and power off alarm supervision.

4. Power Supply: 120 Vac, 60 Hz, single phase. Note: System must have integral or plant uninterruptible power supply unit capable of 15-minute operation in conjunction with Secondary Power Supply defined by NPFA 72.

F. Initiating circuit modules shall maintain complete reporting of device status while in trouble due to any addressable device having its active transmitting component fail, open, or shorted. The initiating circuit modules shall detect a line break and provide information to the control panel, allowing the user to determine between which two devices the break has occurred.

G. Detection line circuit monitoring shall be provided by a zone input module. Each circuit shall be capable of Class A or B wiring. With Class B wiring, a capacitive end-of-line device shall be required. Each zone shall accommodate up to 96 ionization or photoelectric detectors, or 96 flame detectors, as well as any quantity of shorting-type contact devices. Upon actuation of any detector or device installed on a zone circuit, that particular zone shall lock into alarm and the zone identification and location shall be annunciated at the control unit. Zone troubles, such as opens, shall be annunciated at the control unit giving zone identification and trouble description. Alarm information and transmission shall have priority over trouble.

H. An output circuit indicating operation of dc audible devices, leased line or city tie shall be provided by an indicating module. Upon command by the control unit the output circuits will respond as configured. Leased line or city circuits shall be limited energy outputs. All signal circuits shall require and be fitted with an appropriate end-of-line resistor (EOLR). Each circuit shall be fused separately. The module shall be supervised by the control unit for open and shorted circuits. Open circuits shall report trouble only and respond with circuit identification. A shorted circuit shall respond in a similar manner. Each output circuit shall be individually fused with replaceable fuses.

I. For control of air-handling units, elevators, and beacon lights, relay modules shall be provided. The module shall be system interconnected and shall be operable by the control unit or manually. It shall contain eight independent relays, fitted with Form C contacts, rated at 120 Vac, 10 amps, minimum, inductive.

2.4 PERIPHERAL DEVICES

A. All detection devices shall contain an integral alarm LED. All addressable detectors shall be individually identifiable by zone. Mounting bases shall be provided by life safety contractor, included with detector as a complete assembly.

B. The addressable ionization detector shall be a plug in, twist/lock unit, which shall be capable of removal from or installation into its base with one hand.

1. The detector shall contain two ionization chambers and solid-state indicator lamp. The reference chamber shall compensate against sensitivity changes due to changes in

environmental temperature, humidity, and barometric pressure. The sensing chamber shall be open to the outside elements through a protective cover, which will permit product of combustion to enter while preventing foreign matter from entering and causing unwanted alarms.

2. The detector shall be dynamically supervised, indicating a trouble condition at the control panel when the detector is unable to sense a fire condition due to either internal and external operation conditions or malfunctions.

C. The addressable photoelectric smoke detector shall contain an LED as its light source and photodiode as a light receiver. An automatic gain control circuit shall be provided to maintain correct sensitivity by compensating for detector aging and dirt accumulation. The detector shall be a plug in twist/lock unit, which allows for easy connection to its mounting base. The detector shall provide complete supervision of the detector optics. The detector shall be supervised for complete failure of the LED light source or a critical reduction in the light output of the LED caused by excessive dirt, which could not normally be compensated for by the automatic-gain control circuit.

D. The addressable thermal detector shall be of the rate-compensated, fixed-temperature type. The detector shall be individually annunciated on the control panel. The detectors shall contain an integral alarm lamp.

E. The addressable programmable interface module is designed to provide an interface for direct-shorting contact devices. The unit is used with water flow switches, pressure switches, tamper switches on OS&Y valves, and other contact closure devices. The unit shall electrically supervise wiring to contacts via EOLR provided by life safety contractor.

F. The addressable manual pull station shall operate on any addressable detection circuit. The addressable manual pull station shall be individually annunciated on the control panel. The unit shall be double-action initiated, having latching relays.

G. The air duct smoke detector shall operate on a cross-sectional air-sampling principle to overcome stratification and skin effect. The air duct detector shall consist of a standard addressable photoelectric detector mounted in an air duct sampling assembly and sampling tube that protrudes across the duct of the ventilating system. The air duct detector shall retain the features of the addressable photoelectric detector, and be installed in the ventilating duct as indicated in the manufacturer's instructions. The air duct smoke detector shall come with appropriate addressable detector and base, remote test station, and inlet sampling tubes.

H. The detector mounting base shall be of the twist/lock type with screw terminals. Pigtails or in line connectors shall not be permitted. It shall be possible to secure the detector in the base. The detector mounting base shall be universal for addressable photoelectric detectors.

I. Alarm bells shall be of the polarized 24 Vdc type. The mechanisms shall be fully enclosed and dust-proof. They shall be designed to be mounted on a wall, ceiling, or other suitable rigid surface that is free from vibration.

J. Alarm horns shall be of the polarized 24 Vdc type. The mechanisms shall contain an aerospace-grade aluminum diaphragm; blued, tempered, and polished armature, and tungsten contact points, all housed in a die-cast frame-and-grill assembly. They shall be designed to be mounted on a wall, ceiling, or other suitable rigid surface and capable of being surface, semi flush, or flush mounted.

K. EVACUATION SIGNALS

1. Speakers:

a. General

1) Shall be of the polarized 24-Vdc type. Speaker shall be UL listed for fire alarm voice evacuation use. Speakers shall be designed to be mounted on a wall, ceiling or other suitable rigid surface and shall be capable of being surface, semi flush, or flush mounted. Speakers shall be multi-tap. Minimum tap settings shall be 1/16, 1/8, 1/4, 1/2, 1, 2 or 4 or 8 watts.

b. Non-Ceiling Mounted

1) The speaker shall have 70.7 VRMS inputs and have field-selectable power taps from 1/8 watt to 8 watts. Speaker shall have frequency response of 400 to 4,000 Hz and be UL listed for fire alarm voice evacuation use. Speaker shall have vandal-resistant red grill faceplate. Speakers shall be designed to be mounted on a wall or other suitable rigid surface and shall be capable of being surface, semi flush, or flush mounted.

c. Ceiling Mounted

1) The speaker shall have 70.7 VRMS inputs and have field selectable power taps from 1/8 watt to 8 watts. Speaker shall have frequency response of 400 to 4,000 Hz and be UL listed for fire alarm voice evacuation use. Speaker shall have 4 inch cone and shall have 7.25 inch-diameter circular metal faceplate with white enamel finish. Speakers shall be designed to be mounted on a wall, ceiling, or other suitable rigid surface and be capable of being flush mounted.

d. Extra loud

1) The speaker shall have 70.7 VRMS inputs and have field-selectable power taps from 0.9 watt to 15 watts. Speakers shall have frequency response of 400 to 4,000 Hz and be UL listed for fire alarm voice evacuation use. Peak speaker output shall be 121 dB at 4 feet, 15 watt or 111 dB at 10 feet, 15 watt. Speaker shall have high-efficiency compression driver with re-entrant horn, and shall have a baked gray epoxy finish. Speakers shall be designed to be mounted on a wall, ceiling, or other suitable rigid surface, and be capable of being surface mounted.

2. Strobe Light: ADA visual notification appliances shall be compromised of a xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. Provide a unit that is ADA compliant with an output no less than 15 candela. The Lexan lens shall be pyramidal in shape to allow better visibility. Provide a red lens on selected strobes where indicated on plans. Strobe light candela ratings have been shown on the plans. However, contractor is responsible for sizing strobes per NFPA 72 based on room size and device location. Units shall be installed 80” above finished floor. All strobes within the same line of site shall be synchronized. Candela ratings have been shown on the plans. These ratings shall be verified based on the room size and NFPA requirements. Where there are discrepancies The NFPA requirements for candela rating shall take precedence over the values shown on the plans. Provide multi-tap strobes to allow for a full range of candela settings. Settings shall be 15/75, 30/75, 75 or 110 candela. Circuits for strobes shall allow for capacity to increase strobe intensities one setting for all

strobes. Provide spare devices equal to 1% of the total number of new devices provided for this project.

a. Rated voltage shall range from 18 to 31.2 volts for nominal 24 Vdc models.

b. The xenon flash tube and associated circuitry shall be enclosed in a translucent white polycarbonate lens with "fire" inscribed on the lens. Plate color shall be red.

c. The xenon flash tube and associated circuitry shall be enclosed in a translucent white polycarbonate lens with graphics appropriate for mass notifcation inscribed on the lens. Plate color shall be red. Device shall not include the word “FIRE” on device.

3. Speaker/Strobe combination: Standard, ADA Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, chimes or speakers. The unit shall be complete with a tamper resistant, Pyramidal shaped lexan lens with Fire lettering visible from a 180-degree field of view. The front panel or bezel that is constructed of UL Listed Noryl, may be inverted so that the lens is below the audible device. Integral Xenon strobe shall provide 8000 peak candlepower and be adjustable from 1 to 3 flashes per second. Provide a unit approved for ADA compliance. Strobe shall be multi-tap type to allow for a full range of candela settings as indicated in paragraph G. Xenon strobe shall provide 4-wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Audio/visual unit shall be UL listed for its intended purpose. Speaker shall be mulit-tap type to allow for different audio settings as indicated in paragraph F. Provide spare devices equal to 1% of the total number of new devices provided for this project.

4. The evacuation signals shall be available in flush, semi-flush, or surface versions as required for signal locations shown on the contract documents. Signals shall be mounted using a listed outlet box, and as required, tile bridges. Signals shall be available in visual only and combination to satisfy all required project applications. Visual only and combination audio/visual alarms shall be white with red "FIRE" lettering.

L. Water flow switches: Flow switches shall be UL listed for its intended purpose; furnished under Division 23 and electrically connected under Division 26. Individual addressable modules shall be provided on each switch.

M. Sprinkler Valve Tamper Switches: Switch shall be provided with either one or two sets of SPDT micro switches as required. Tamper switch shall be UL listed for its intended purpose, furnished under Division 23 and electrically connected by Division 26. Individual addressable modules shall be provided on each switch.

N. Firefighter's emergency telephone shall include handset, cradle with switch hook and heavy gauge steel enclosure. Handset shall be red, high-impact plastic with retractable coil cord. Telephone assembly shall permit two-way communication from fire alarm audio control panel and shall produce a distinct zone or call-in signal when the handset is removed from its cradle. Enclosure shall be finished in baked, red enamel and shall bear a silk-screened handset symbol and the words "emergency telephone". Enclosure shall be suitable for flush or surface mounting. Anticipated enclosure size shall be 5 1/8 inches wide by 8 1/8 inches high by 3 inches deep.

O. SPARE BOX

1. Provide a separate box located adjacent to the main fire alarm panel. The box shall be sufficiently sized (16” X 16” C 6” minimum) to hold all spare detectors and paperwork. This box shall match the main fire alarm panel in appearance and be keyed the same.

P. REMOTE CIRCUIT INTERFACE PANELS

1. Remote circuit interface panels shall consist of an enclosure, a remote power supply, digital communications circuitry, mother boards, batteries and hardware, modules and circuitry described for inclusion in the fire alarm control panel as required to function as specified.

    a. Circuit interface panels, when required, include conventional zone module, analog loop drivers, indicating appliance circuits, output circuitry to perform actions, speaker supervisory and distribution circuits. All fire detection, alarm and indicating devices supported by the circuit interface panel shall function as a self standing system in the failsafe mode upon loss of the central fire alarm control panel processing, communications or the communications wiring between them.

    b. Smoke detectors shall alarm at their programmed sensitivity settings and shall not revert to a common default setting when their operating system segment is in the default mode.

    c. Circuit interface panels shall support remote system displays, annunciators and printers. Test procedures shall be capable of initiation at the main fire control panel, any remote LCD annunciator or any remote interface panel equipped with a keypad.

Q. MAGNETIC HOLD OPEN DEVICE

1. Provide 120VAC magnetic hold open devices where indicated on plans and where required by Code. Devices shall close on an alarm.

R. FIRE SPRINKLER SYSTEM DETECTION AND SUPERVISION

1. Furnish sensors for installation by the fire sprinkler system contractor and provide system interconnection for the following functions.

    a. Waterflow switches, vane type, with adjustable pneumatic retard of 0 - 75 seconds, single pole double throw switch calibrated for actuation when flow rate equals 10 GPM or greater.

    b. Outside screw and yoke valve supervisory switches in sizes as required for monitoring valves. The single pole double throw supervisory switch shall activate an off normal report within one half turn of the valve.

S. INTELLIGENT SUPERVISED CONTROL MODULE

1. Furnish and install for the control of supervised relays, contactors, audible signal circuits, visual signal circuits, distributed speaker circuits and two way fire fighters communication circuits, intelligent supervisory and control modules including features as follows:

    a. The modules shall be suitable for two wire operation and communications on intelligent analog alarm detection loops. Address assignments shall be accomplished electronically. Devices requiring dip switches, rotary switches, staples and/or jumpers are not acceptable.

    b. The module shall display a steady LED in the normal power or standby power condition, when in the activated state.

c. The module shall be suitable for semi-flush or surface mounting in a 2" deep, 4" square or double gang electrical outlet box having a depth of 3 1/2".

2. Modules shall be available to supervise reverse polarity supervised indicating circuits utilizing 24VDC, two way supervised fireman's communication circuits or audio circuits utilizing 25VRMS or 70.7VRMS. It shall be possible to configure the module for control of motor contractors and AC voltages to 115VAC.

a. All connected field wiring shall be supervised for opens, short circuits and grounded circuits.

b. All controlled circuits shall be power limited at 1.5A, produced by self restoring thermal components. Units requiring circuit replacement for restoration of outputs are not acceptable.

1) Signal outputs shall be supported in either Style "Y" or Style "Z" configuration.

2) The module shall report a trouble condition in the event of loss of the 24VDC signal operating supply voltage.

T. SECURITY INTERFACE TERMINAL BOX

1. The interface terminal box shall be a lockable continuous hinge cover NEMA Type 4 enclosure. The cover of the enclosure shall be labeled to identify it's function.

2. Dual screw barrier type terminal strips shall be provided within the interface terminal box. Terminals shall be provided for each interface output from the fire alarm system and the manual unlock keyswitch. All terminals shall be labeled to identify their function.

3. The output contacts from the fire alarm system shall be rated for 1A at 120V.

U. MANUAL UNLOCK SWITCH FOR SECURITY SYSTEM

1. The manual unlock switch shall be a maintained DPDT contact toggle switch. The contacts shall be rated for 1 A at 120V.

2. The switch shall be mounted on a single gang plate with a guard to prevent the switch from inadvertently being activated.

3. The switch shall be labeled to identify its function, the locked position, and the unlocked position.

2.5 *****SPEC WRITER NOTE – FOR MASS NOTIFICATION SYSTEMS***MASS NOTIFICATION PANEL

A. Provide and install a new EST3 FACP/Mass Notification system consisting of:

1. Building command center.

2. LCD annunciator.

3. Multi-channel one-way voice communication system.

4. Audible appliances

5. Synchronized visual appliances.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the areas and conditions under which the fire alarm system is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install system and materials in accordance with the manufacturer's written instructions, drawing set, and details, the applicable requirements of the NEC and NFPA 72, and specifications in Division 26.

B. Junction boxes used as back boxes for fire alarm system field devices shall be 4-inch square with 2 1/8-inch minimums in depth. Install adapter plates and extension rings where required. Junction boxes for concealed conduit system shall be flush mounted.

C. Mount outlet box for electric door holder to withstand 80 pound-pulling force.

D. Upon initial installation, all fire alarm detection devices shall have the original plastic dust covers installed. Dust covers shall not be removed until installation is completed and the system is ready for test.

E. Each conductor shall be identified as shown on the shop drawings by attaching permanent alphanumeric wire markers within 2 inches of the wire termination at both ends. Marker legends shall be visible. Junction box and pull box covers shall be painted yellow or have embossed adhesive tape labeling that is minimum 1/4 inch white letters over a yellow background with text “Fire Alarm”. Install end of line device in box with text “End-of-Line” or “EOL”. Number-code or color-code conductors, appropriately and permanently for identification and servicing of system.

F. Splices shall only be made on terminal strips. All fire alarm wring shall be installed in raceways as per drawing. All external wiring shall be color-coded and shall not be installed in the same outlet box, junction box, or conduit with conductors of lighting or power systems.

G. Locate and install the detector assembly for optimum response time and easy accessibility.

H. Provide manual pull stations at every identified egress and installed in compliance with the maximum distance from the operable egress door per NFPA 72.

3.3 TESTING

A. The entire fire alarm system shall be field tested in accordance with NFPA standards and other applicable standards in the presence of the Construction Inspector. Inspection and test method shall be in compliance with NFPA 72. Inspection and test record forms that are recommended by NFPA 72 shall be utilized. Results of such testing shall be recorded on forms approved for the purpose, certified and submitted to the Construction Inspector prior to final acceptance.

B. All test equipment; instruments, tools, and labor that required conducting the system tests shall be provided by the Contractor. The following equipment, but not limited to, shall be a minimum for conducting such tests.

1. Ladders and scaffolds as required for access all field devices.

2. Multi-meter for reading voltage, current and resistance.

3. Intelligent device programmer/tester.

4. Laptop computer with programming software for any required program revisions.

5. Two-way radios, flashlights, smoke generation devices and supplies.

6. Spare printer paper.

7. Decibel meter.

C. Perform all electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, measure and adjust each of the ionization detectors to the maximum stable sensitivity setting. This must be performed with the detector at its operational environmental conditions in the area. Bench settings are not acceptable. All test and report costs shall be in the contract price. A checkout report shall be prepared by the installation technicians and submitted in triplicate, of which one copy will be registered with the equipment manufacturer. The report shall include, but not be limited to:

1. A complete list of equipment installed and wired.

2. Indication that all equipment is properly installed and functions and conforms to these Specifications.

3. Serial numbers, locations by zone and model number for each installed detector. All intelligent devices shall be tested and logged for correct address and sensitivity using test equipment specifically designed for that purpose. Sensitivity settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.

4. Wiring runs shall be tested for continuity, short circuits and ground before system is energized. Resistance, current and voltage reading shall be made as work progresses.

    a. A systematic record shall be maintained for all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates, and witnesses.

    b. The Owner shall be notified before the start of the required tests. All items found at variance with the applicable drawings and/or specifications during testing and inspection by the Owner, shall be corrected by Contractor at no additional cost to the Owner.

    c. Test reports shall be delivered to the Owner when completed.

5. Test of individual zones as applicable.

6. Duct detector cfm readings with HVAC system operating.

7. HVAC shutdown response upon smoke detection.

8. Water flow alarm response upon water flow or tamper switch activation.

9. Elevator recall, alternate floor recall, and power shutdown response.

10. Firefighter’s emergency telephone response time.

11. Response time on thermostats and flame detectors (if used).

12. Technician's name, certificate number, and date.

D. Final Acceptance Test (FAT)

1. The FAT shall be conducted in the presence of the Owner and under the supervision of the Manufacturer. Prior to FAT, the Owner shall be provided drawings showing the correct address for all addressable alarm initiation devices. The address shall be shown in their respective locations for the device on drawings. Signals shall be sequentially numbered as the address of the controlling module.

2. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:

   a. Open, short, and ground fault for intelligent analog signaling circuit.

   b. Open, short, and ground fault for intelligent digital signaling circuit.

   c. Open, short, and ground fault for network signaling circuit.

   d. Intelligent device removal.

   e. Primary power or battery disconnected.

   f. Type of device miss-match the address ID.

   g. Polarity check.

   h. Printer trouble, off line or out of paper.

3. System indications shall be demonstrated as follows.

   a. Correct message display for each alarm input at the remote control panel, central control panel and operator’s workstation graphic display.

      1) Correct annunciator light for each alarm input at each annunciator and color graphic of operator’s workstation.

      2) Correct printer logging for all system activity.

   b. Secondary power capacities shall be demonstrated as follows.

      1) System primary power shall be disconnected for a period of 8 hours. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period of 5 [15] minutes.

      2) System primary power shall be restored 48 hours and system charging current shall be normal trickle charge for a fully charges battery pack.

3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test code and displayed on the LCD display.

c. Firefighter's HVAC override system functions shall be demonstrated as following.

1) On/off control of each controlled element and test for interaction of others automatic and manual control functions while in the override mode.

2) Correct status display of monitored elements.

3) Correct logging of activity to printer and historical memory as programmed.

4. The entire system needs to be tested in compliance with the building emergency operation sequence specified by contract document. The tests are included, but not limited to, fire door control, security door control interface, air handler duct smoke detection shutdown interface, sprinkler system PIVs, OS&Y valves, and tamper switch monitoring, sprinkler systems water flow and/or pressure switch monitoring, monitoring of fire pump controls, fire/smoke damper control, smoke purge control interface, activation of deluge or pre-action sprinkler systems, and elevator recall power shutdown.

5. In the event of system failure to perform as specified and programmed during the FAT, the test shall be terminated at the discretion of the Owner.

a. The Contractor shall retest the system correcting all deficiencies and providing test documentation to the Owner without additional cost to the Owner.

b. In the event that software changes are required during the FAT, a utility program shall be provided by the system manufacturer to compare the edited program with the original. The utility shall field a printed list of the changes and all system functions, inputs and outputs affected by the changes. The items listed by the program shall be the minimum acceptable to be retested before calling for resumption of the FAT. The printed list and the printer log of the retesting shall be submitted before scheduling of the FAT.

c. The Owner may elect to require the complete FAT to be performed again if, in their opinion, modifications to the system hardware or software warrant complete retesting.

6. Verify, test, and demonstrate all Mass Notification system communication and operation with the control from origin of Mass Notification System.

7. Verify, test and demonstrate the interface between the local Fire Alarm System and the local Mass Notification system

3.4 WARRANTY AND SERVICES

A. The Contractor shall warrant the entire system against mechanical and electrical defects for a period of 18 months. This period shall begin upon completed certification and test of the system.

B. During the warranty period, provide at no additional charge the inspection, parts, maintenance, testing and repair in full compliance with the requirements of NFPA 72. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.

3.5 MANUFACTURER'S FIELD SERVICES

A. Include services of factory-certified technicians to supervise installation, adjustments, calibrations, final connections, and system testing. A representative of the manufacturer shall instruct the Owner and demonstrate the system after the Owner has occupied the building.

B. Formal training for the operation and maintenance of fire alarm equipment and the systems specified herein shall be provided by manufacturer trained and certified personnel. The formal training shall consist of a minimum of five-day eight-hour training sessions or the number of hours as indicated per contract document. The timing of the training shall coincide with the schedule for the manufacturer's representatives to be on site for testing and start-up of each building fire alarm system. The formal training shall be provided at a location designated or provided by the Owner for number of personnel selected by the Owner, in addition to any informal on-site orientation and training.

C. A formal training proposal shall be submitted with curriculum material, schedule, instructor's qualification for the Owner's approval at least 60 days prior to formal training. The trainer shall provide approved training material manus at the time of training with quantity of copies per Owner's instruction.

D. As-built drawings shall be provided upon acceptance of the system with quantities per contract document.

END OF SECTION

SECTION 31 1000

SITE CLEARING

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

2.01SITE CLEARING

A. Comply with other requirements specified in Section 01 7000.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

2.02VEGETATION

A. Do not remove or damage vegetation beyond the limits indicated on drawings.

B. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.

C. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

D. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.

E. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

2.03DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 31 1101
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01GENERAL DESCRIPTION OF WORK

A. Cleaning and grubbing on project site of trees, stumps, brush, roots, vegetation, logs rubbish and other objectionable matter within limits described in specifications or as shown on plans. Refer to Structural plans and specifications for building pad.

B. Cleaning and grubbing shall be in advance of grading operation except that in cuts over 3 feet in depth, grubbing may be done simultaneously with excavation, provided objectionable matter is removed as specified.

C. Disposal of all debris resulting from clearing and grubbing work.

D. PROTECTION OF ADJACENT WORK:

E. Protect all areas outside indicated construction areas.

F. Protect existing improvements, adjacent property, utilities and other facilities, and trees and plants not to be removed from injury or damage.

PART 2 - PRODUCTS

2.01MATERIALS:

A. Provide materials required to perform work as specified.

PART 3 - EXECUTION

3.01CLEARING:

A. Clear all areas covered by dikes, roads, structures and embankments within project limits unless otherwise shown in plans.

B. Remove all saplings, brush, down-timber and debris unless shown or directed otherwise.

C. GRUBBING:

D. Trees, stumps, root systems, rocks and other obstructions shall be removed to the depths shown when they fall within the construction templates for the following items:

1.	Sidewalks (or other types of walks	12-riches below bottom of walk.
2.	Roadways or Streets	18-inches below bottom of sub-grade
3.	Grassed Areas	18-inches below topsoil
4.	Fills	24-inches below bottom of fill

E. Blasting not permitted.

F. REMOVAL OF DEBRIS AND CLEANUP

G. Dispose of all waste materials not burned by removal from site.

H. Materials cleared and grubbed shall be the property of the Contractor and shall be his responsibility for disposal.

I. CLEARING AND GRUBBING:

J. When not listed as separate contract pay item, Clearing and Grubbing shall be considered as incidental work, and the cost thereof shall be included in such contract pay items as are provided in the proposal contract.

K. Compensation, whether by contract pay item or incidental work will be for furnishing all materials, labor equipment, tools and in incidentals required for the work, all in accordance with the plans and these specifications.

END OF SECTION

SECTION 31 2200
GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading the site for site work excluding building pad..

C. Finish grading.

1.02 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing.

B. Section 31 1101- Clearing and Grubbing

C. Section 31 2316.10 - Excavation.

D. Section 31 2316.13 - Trenching: Trenching and backfilling for utilities.

E. Section 31 2316.26 - Rock Removal.

F. Section 31 2323 - Fill: Filling and compaction.

1.03 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.04 QUALITY ASSURANCE

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

B. Verify the absence of standing or ponding water.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

D. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

E. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

F. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

G. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

C. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

D. When excavating through roots, perform work by hand and cut roots with sharp axe.

E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

F. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch in size. Remove soil contaminated with petroleum products.

C. Where topsoil is to be placed, scarify surface to depth of see landscaping plans for thickness inches.

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

E. Place topsoil in areas where seeding are indicated.

F. Place topsoil in areas indicated.

G. Place topsoil to thickness as indicated.

H. Place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: see landscaping plans for thickness inches.
   2. Areas to be Sodded: see landscaping plans for thickness inches.
   3. Shrub Beds: see landscaping plans for thickness inches.
   4. Flower Beds: see landscaping plans for thickness inches.
   5. Planter Boxes: To within see landscaping plans for thickness inches of box rim.

I. Place topsoil during dry weather.

J. Remove roots, weeds, rocks, and foreign material while spreading.

K. Near plants spread topsoil manually to prevent damage.

L. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

M. Lightly compact placed topsoil.

N. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.05 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.06 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Engineer as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size as directed by ARCHITECT.

3.07 FIELD QUALITY CONTROL

A. See Section 31 2323 for compaction density testing.

3.08 CLEANING

A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 2316.10
EXCAVATION - CIVIL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trenching for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Section 01 5713 - Temporary Erosion and Sedimentation Control: Slope protection and erosion control.

B. Section 31 2200 - Grading: Soil removal from surface of site.

C. Section 31 2200 - Grading: Grading.

D. Section 31 2316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

E. Section 31 2316.26 - Rock Removal: Removal of rock during excavating.

F. Section 31 2323 - Fill: Fill materials, filling, and compacting.

1.03 PRICE AND PAYMENT PROCEDURES

1.04 SUBSIDIARY TO PROJECT COST

A. See Section 01 2200 - Unit Prices, for general requirements applicable to unit prices for excavation.

1.05 PROJECT CONDITIONS

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

PART 3 EXECUTION

2.01 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 2200 for additional requirements.

C. Locate, identify, and protect utilities that remain and protect from damage.

D. Notify utility company to remove and relocate utilities.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

F. Protect plants, lawns, rock outcroppings, and other features to remain.

2.02 EXCAVATING

A. Excavate to accommodate new structures and construction operations.

B. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Preparation for Piling Work: Excavate to working elevations. Coordinate special requirements for piling.

D. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

E. Do not interfere with 45 degree bearing splay of foundations.

F. Cut utility trenches wide enough to allow inspection of installed utilities.

G. Hand trim excavations. Remove loose matter.

H. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 2323.

I. Grade top perimeter of excavation to prevent surface water from draining into excavation.

J. Remove excavated material that is unsuitable for re-use from site.

K. Remove excess excavated material from site.

2.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

2.04 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

END OF SECTION

SECTION 31 2316.13
TRENCHING

PART 3 EXECUTION

1.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

1.02 TRENCHING

A. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove excavated material that is unsuitable for re-use from site.

G. Remove excess excavated material from site.

H. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Engineer. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

I. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Engineer.

1.03 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

1.04 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Correct areas that are over-excavated.
   1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

G. Compaction Density Unless Otherwise Specified or Indicated:

H. Reshape and re-compact fills subjected to vehicular traffic.

1.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

1.06 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection and testing.

B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("modified Proctor"), AASHTO T 180, or ASTM D698 ("standard Proctor").

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

D. Frequency of Tests: _____.

END OF SECTION

SECTION 31 2316.14
TRENCH PROTECTION SYSTEM

PART 1 - GENERAL

1.01 GENERAL DESCRIPTION OF WORK

A. This work shall consist of shoring, bracing, bank stabilization, bank sloping, providing trench boxes or trench shields or other equivalent means to protect employees from the effects of moving ground or cave-ins for all trenches 5-feet or more in depth.

B. All work shall be done in conformance with OSHA Safety and Health Standards (29 CFR 1926/1010 Chapter XVII Subpart P-Excavations, Trenching and Shoring.).

C. DEFINITIONS APPLICABLE TO THIS SPECIFICATION

D. "Accepted engineering requirements (or practices)" - Those requirements or practices which are compatible with standards required a Registered Professional Engineer, or other duly licensed or recognized authority.

E. "Angle of repose" - The greatest angle above the horizontal plane at which a material will lie without sliding.

F. "Bank" - A mass of soil rising above a digging level.

G. "Belled excavation" - A part of shaft or footing excavation, usually near the bottom and bell-shaped; i.e., an enlargement of the cross section above.

H. "Braces (trench)" - The horizontal members of the shoring system whose ends bear against the uprights or stringers.

I. "Excavation" - Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench.

J. "Faces" - See paragraph (k) of this section.

K. "Hard compact soil" - All earth materials not classified as running or unstable.

L. "Kickouts" - Accidental release or failure of a shore or brace.

M. "Sheet pile" - A pile, or sheeting, that may form one of the continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall to resist the lateral pressure of water, adjacent earth, or other materials.

N. "Sides", "Walls", or "Faces" - The vertical or inclined earth surfaces formed as a result of excavation work.

O. "Slope" - The angle with the horizontal at which a particular earth material will stand indefinitely without movement.

P. "Stringers" (wales) - The horizontal members of a shoring system whose sides bear against the uprights or earth.

Q. "Trench" - A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 ft.

R. "Trench shield" - A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.

S. "Unstable soil" - Earth material, other than running, that because of its nature of the influence of related conditions, cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.

T. "Uprights" - the vertical members of a shoring system.

U. "Wales" - See paragraph M of this section.

V. "Walls" - See paragraph K of this section.

PART 2 - PRODUCTS

2.01 NO INFORMATION FOR THIS SECTION

PART 3 - EXECUTION

3.01 GENERAL PROTECTION REQUIREMENTS

A. Walkways, runways, and sidewalks shall be kept clear of excavated material or other obstructions and no sidewalks shall be undermined unless shored to carry a minimum live load of one hundred and twenty-five (125) pounds per square foot.

B. If planks are used for raised walkways, runways, or sidewalks they shall be laid parallel to the length of the walk and fastened together against displacement.

C. Planks shall be uniform in thickness and all exposed ends shall be provided with beveled cleats to prevent tripping.

D. Raised walkways, runways, and sidewalks shall be provided with plank steps on string stringers. Ramps, used in lieu of steps, shall be provided with cleats to insure a safe walking surface.

E. All employees shall be protected with personal protective equipment for the protection of the head, eyes, respiratory organs, hands, feet and other parts of the body as set forth in OSHA Standards.

F. Employees exposed to vehicular traffic shall be provided with and shall be instructed to wear warning vests marked with or made or reflectorized with high visibility material.

G. Employees subjected to hazardous dusts, gases, fumes, mists, or atmospheres deficient in oxygen, shall be protected with approved respiratory protection as set forth in OSHA Standards.

H. No person shall be permitted under loads handled by power shovels, derricks, or hoists. To avoid any spillage, employees shall be required to stand away from any vehicle being loaded.

I. Daily inspections of excavations shall be made by a competent person. If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions have been taken to safeguard employees.

J. SPECIFIC EXCAVATION REQUIREMENTS

K. Prior to opening an excavation, effort shall be made to determine whether underground installations, i.e., sewer, telephone, water, fuel, electric lines, etc., will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.

L. Trees, boulders, and other surface encumbrances, located so as to create a hazard employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed o made safe before excavating is begun.

M. The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground or some other equivalent means.

N. Excavations shall be inspected by a competent person after ever rainstorm or other hazard-increasing occurrence, and the protection against slides and cave-ins shall be increased if necessary.

O. The determination of the angle of repose and design of the supporting system shall be based on careful evaluation of pertinent factors such as: Depth of cut; possible variation in water content of the material while the excavation is open; anticipated changes in materials from

exposure to air, sun, water, or freezing; loading imposed by structures, equipment, overlying materials, or stored material; and vibration from equipment, blasting, traffic, or other sources.

P. Supporting systems, i.e., piling, cribbing, shoring, etc., shall be designed by a qualified person and meet accepted engineering requirements. When tie rods are used to restrain the top of sheeting or other retaining systems, the rods shall be securely anchored well back of the angle of repose. When tight sheeting or sheet piling is used, full loading due to ground water table shall be assumed, unless prevented by weep holes or drains or other means. Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.

Q. All slops shall be excavated to at least the angle of repose except for areas where solid rock allows for line drilling or presplitting.

R. The angle of repose shall be flattened when an excavation has water conditions, silty materials, loose boulders, and areas were erosion deep frost action and slide planes appear.

S. Clearances:
   1. In excavations which employees may be required to enter, excavated or other material shall be effectively stored and retained at least 2-feet or more from the edge of the excavation.
   2. As an alternative to the clearance prescribed in subparagraph 1, the Contractor may use effective barriers or other effective retaining devices in lieu thereof in order to prevent excavated or other materials from falling into the excavation.

T. Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, benching, barricading, rock bolting, wire meshing, or other equally effective means. Special attention shall be given to slopes which may be adversely affected by weather or moisture content.

U. Support systems shall be planned and designed by a qualified person when excavation is in excess of 20-feet in depth, adjacent to structures or improvements, or subject to vibration or ground water.

V. Materials used for sheeting, sheet piling, cribbing, bracing, shoring and underpinning shall be in good serviceable condition, and timbers shall be sound, free from large or loose knots, and of proper dimensions.

W. Special precautions shall be taken in sloping or shoring the sides of excavations adjacent to previously backfilled excavation for a fill, particularly when the separation is less than the depth of the excavation. Particular attention also shall be paid to joints and seams of material comprising a face and the slope of such seams and joints.

X. Except in hard rock, excavations below the level of the base of footing of any foundation or retaining wall shall not be permitted, unless the wall in underpinned and all other precautions taken to insure the stability of the adjacent walls for the protection of employees involved in excavation work or in the vicinity thereof.

Y. If the stability of adjoining building or walls is endangered by excavations, shoring, bracing or underpinning shall be provided as necessary to insure their safety. Such shoring, bracing or underpinning shall be inspected daily or more often, as conditions warrant, by a competent person the protection effectively maintained.

Z. Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in an excavation.

AA. If it is necessary to place or operate power shovels, derricks, trucks, excavation, the side of the excavation shall be sheet-piled, shored, and braced as necessary to resist the extra pressure due to such superimposed loads.

AB. Blasting and the use of explosives are not allowed unless authorized in other portions of the specifications.

AC. When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed. if possible, the grade should be away from the excavation.

AD. Adequate barrier physical protection shall be provided at all remotely located excavations. All wells, pits shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc. shall be backfilled.

AE. If possible, dust conditions shall be kept to a minimum by the use of water, salt, calcium chloride, oil, or other means.

AF. In locations where oxygen deficiency or gaseous conditions are possible, air in the excavation shall be tested. Controls, as set forth in OSHA Standards shall be established to assure acceptable atmospheric conditions. When flammable gases are present, adequate ventilation shall be provided or sources of ignition shall be eliminated. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, basket stretcher, etc. shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.

AG. Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.

AH. Where ramps are used for employees or equipment, they shall be designed and constructed by qualified persons in accordance with accepted engineering requirements.

AI. All ladders used on excavation operations shall be in accordance with requirements of OSHA Standards.

AJ. SPECIFIC TRENCHING REQUIREMENTS

AK. Banks more than 5-feet shall be shored, laid back to a stable slope or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Trenches less that 5-feet in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.

AL. Sides of trenches in unstable or soft material, 5-feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them.

AM. Sides of trenches in hard or compact soil, including embankments, shall be shored or otherwise supported when the trench is more than 5-feet in depth and 8-feet or more in length. In lieu of shoring, the sides of the trench above the 5-foot level many be sloped to preclude collapse, but shall not be steeper than a 1-foot rise to each 1/2-foot horizontal. When the outside diameter of a pipe is greater than 6-feet, a bench of 4-foot minimum shall be provided at the toe of the sloped portion.

AN. Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.

AO. Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.

AP. Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier and securely fastened to shoulder harness, shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.

AQ. Minimum requirements for trench timbering shall be in accordance with Table 19000-1. Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stresses in excess of values given by the following formula:

1. S + 1300 - 20L
   a. Maximum L = 50
   b. Ratio D
2. Where:
3. Length, unsupported, inches
4. Least side of the timber in inches
5. Allowable stress in pounds per square inch of cross-section.

AR. When employees are required to be in trenches 4-feet deep or more, an adequate means of exit, such as a ladder or steps shall be provided and located so as to require no more than 25-feet of lateral travel.

AS. Bracing or shoring of trenches shall be carried along with the excavation.

AT. Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling, or kickouts.

AU. Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system or sloping. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench. The Contractor shall provide a statement certified by a Registered Professional Engineer of the adequacy of trench boxes or shields.

AV. Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

AW. CONSTRUCTION REQUIREMENTS

AX. The Contractor unless provided for in the plans otherwise shall provide the minimum shoring shown in Table 19000-1 for the soil class noted in the plans.

AY. Should the soil conditions differ form those specified or should ground water be encountered int eh excavation the contractor shall notify the Engineer immediately. The Contractor shall refrain from operating in that portion of the trench where changed conditions are noted until such time as an inspection of conditions takes place and the contractor is notified of measures necessary for continued operation.

AZ. The Contractor shall prepare and submit a plan of operation. This plan of operation shall identify material, equipment, methods and installation and shall be inspected by a Registered Professional Engineer. The Contractor's Engineer shall certify the adequacy of the trench protection system and its adherence of OSHA Standards.

BA. PART 4- MEASUREMENT AND PAYMENT

BB. MEASUREMENT

BC. Providing shoring in trenches or other alternate means in accordance with this specification shall be measured by the linear foot of trench of specified sizes or sizes of pipe in ranges of depth to the invert elevation of the pipe or structure. Additional depth for foundations, etc. shall be considered incidental to the price bid for the protection.

BD. The Contractor shall provide shoring systems for construction of structures 5-feet or greater in depth. There will be no direct payment for these systems but it shall be considered incidental to the price bid for the structure.

BE. PAYMENT

BF. Trench protection shall be full compensation for providing acceptable shoring or other alternate means, installing, inspecting, certifying and maintaining the shoring and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

BG. SEE ATTACHED TABLE

END OF SECTION

SECTION 31 2316.26
ROCK REMOVAL

PART 1 GENERAL

1.01SECTION INCLUDES

A. Removal of identified rock during excavation.

1.02RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

B. Section 31 2323 - Fill: Fill materials.

1.03PRICE AND PAYMENT PROCEDURES

1.04SUBSIDIARY TO PROJECT COST.

A. See Section 01 2200 - Unit Prices, for additional unit price requirements.

1.05DEFINITIONS

A. Site Rock: Solid mineral material with a volume in excess of 1/3 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel without drilling.

B. Trench Rock: Solid mineral material with a volume in excess of 1/6 cubic yard or solid material that cannot be removed with a ____ cubic yard capacity power shovel without drilling.

PART 2 PRODUCTS

2.01NOT USED

PART 3 EXECUTION

3.01EXAMINATION

A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.02PREPARATION

A. Identify required lines, levels, contours, and datum.

3.03ROCK REMOVAL

A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.

B. Form level bearing at bottom of excavations.

C. Remove shaled layers to provide sound and unshattered base for footings.

D. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.

E. Remove excavated materials from site.

F. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 2323.

3.04FIELD QUALITY CONTROL

A. Independent agency field inspection will be provided under provisions of Section 01 4000 - Quality Requirements.

END OF SECTION

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Requirements of Drawings, General and Supplementary Conditions and Division 1 apply to this Section.

1.2 SCOPE

A. Provide all termite control work including but not necessarily limited to:
   1. Soil treatment for termite control.

B. Related work specified elsewhere:
   1. Earthwork DIVISION 31
   2. Excavation and backfill for mechanical & electrical installations DIVISIONS 23 & 26

1.3 QUALITY ASSURANCE

A. In addition to requirements of these Specifications, comply with manufacturer's instructions and recommendations for work, including preparation of substrate and application.

B. Engage a professional pest control operator, licensed in accordance with regulations of governing authorities for application of soil treatment solution, and who is experienced and has completed successful termite control treatment installations similar to that indicated for this project.

C. Use only termiticides which bear a Federal registration number of the U.S. Environmental Protection Agency and are approved by local authorities having jurisdiction.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and application instructions, including EPA – Registered Label. Include dilution rates and application rates at each type of area to be treated.

1.5 SPECIFIC PRODUCT WARRANTY

A. Furnish written warranty certifying that applied soil poisoning treatment will prevent infestation of subterranean termites and, that if subterranean termite activity is discovered during warranty period, Contractor will re-treat soil and repair or replace damage caused by termite infestation.
   1. Provide warranty for a period of 5 years from date of treatment, signed by Applicator and Contractor.
   2. The warranty shall not deprive the Owner of other rights the Owner may have under other Provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.6 PROJECT CONDITIONS

A. Do not apply soil treatment solution until excavating, filling and grading operations are completed, except as otherwise required in construction operations.

B. To insure penetration, do not apply soil treatment to frozen or excessively wet soils or during inclement weather. Comply with handling and application instructions of the soil toxicant manufacturer, EPA – Registered Label requirements, and other authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT SOLUTION

A. Use a soluble or emulsible concentrate insecticide for dilution with water or foaming agent, specially formulated to prevent infestation by termites. Use only soil treatment solutions that are not harmful to plants. Fuel oil will not be permitted as a diluet. Provide a working solution at the manufacturer's recommended concentration solution of one of following chemical elements and concentrations:

B. 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:
   1. BASF Corporation; "Termidor".
   2. Other solutions may be used as recommended by Applicator and if acceptable to local governing authorities. Use only soil treatment solutions which are not injurious to planting.
   3. Spray Indicator: As recommended by the pesticide manufacturer.

PART 3 – EXECUTION

3.1 COORDINATION

A. Coordinate soil treatment application with excavating, filling, and grading concreting operations. Treat soil under slabs and other construction before overlying construction occurs.

3.2 APPLICATION

A. General: Comply with most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

B. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control. Proceed with application only after unsatisfactory conditions have been corrected.

C. Comply with most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.

D. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements or authorities having jurisdiction.

E. Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and foundations. Termiticides may be applied before placement of compacted fill under slabs, if recommended by toxicant manufacturer.

F. Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous

horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute the treatment evenly.

1. Mix with a temporary dye spray indicator solution as recommended by the pesticide manufacturer.

G. Foundations: Treat adjacent soil including soil along entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers, piers and along entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.

H. Slabs-on-Grade: Test soil underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed, as an overall treatment under slabs, at all critical areas such as plumbing and penetrations, and trench application at outside perimeter of slabs and foundation walls.

I. Existing Building Foundation Posts and Perimeter Area: Test soil around all foundation posts and entire perimeter and all critical areas such as plumbing and other floor penetrations as an overall treatment.

J. Penetrations: Treat soil at expansion joints, control joints, and areas where slabs will be penetrated.

K. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

L. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

M. Post signs in areas of application warning workers that soil termiticide treatment has been applied. Remove signs after areas are covered by other construction.

N. Reapply soil treatment solution to areas disturbed by subsequent excavation, landscape grading or other construction activities following application.

END OF SECTION

SECTION 31 3700
RIPRAP

PART 1 GENERAL

1.01SECTION INCLUDES

A. Riprap .

1.02RELATED REQUIREMENTS

A. Section 31 2323 - Fill: Aggregate requirements.

1.03PRICE AND PAYMENT PROCEDURES

A.

B. See Section 01 2200 - Unit Prices, for additional unit price requirements.

1.04QUALITY ASSURANCE

A. Perform Work in accordance with State of Texas Highways standard.

PART 2 PRODUCTS

2.01MATERIALS

A. Riprap: Provide in accordance with State of Texas Highways standards.

B. Aggregate: Granular fill as specified in Section 31 2323.

PART 3 EXECUTION

3.01EXAMINATION

A. Do not place riprap bags over frozen or spongy subgrade surfaces.

3.02PLACEMENT

A. Place geotextile fabric over substrate, lap edges and ends.

B. Place riprap at culvert pipe ends, embankment slopes, and as indicated.

END OF SECTION

SECTION 316329 - DRILLED PIERS

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 this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Dry-installed or slurry displacement-installed drilled piers, at Contractor's choice.

B. Work Included

1. Furnish all labor and materials required to construct drilled concrete piers complete including layout, excavation of shafts, excavation of belled bottoms, temporary steel casings, fabrication and installation of reinforcing steel, furnishing and placing concrete, setting anchor bolts and removal of spoil.

C. Related Sections include the following:

1. Division 1 Section "Unit Prices" for list of unit prices.

2. Division 3 Section "Cast-in-Place Concrete" for general structural and building applications of concrete.

3. Division 5 Section “Structural Steel” for anchor rods installed in drilled piers.

1.3 UNIT PRICES

A. Basis of Bids: Base bids on indicated number of drilled piers; design length from top elevation to bottom of shaft, extended through the bell, if applicable; and diameter of shaft and bell.

B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and approved. Actual length, shaft diameter and, if applicable, bell diameter may vary to coincide with elevations where satisfactory bearing strata are encountered, and with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.

1. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for complete drilled-pier installation.

2. See Division 1 Section "Unit Prices" for list of unit prices.

C. Contract price shall be based on base lengths of piers shown on the Drawings. Unit prices shall be as follows:

1. Unit prices per linear foot for piers longer or shorter than base lengths.

2. Unit prices per linear foot for casing. Measurement for payment shall be from top of pier to top of bearing stratum.

D. The cost of casings shall be included in the base price for piers. If casings are not used, the Contract shall be adjusted based on the unit price.

E. Unit prices shall include all labor and materials including overhead and fees for drilled concrete piers. Adjustments to the Contract shall be based on total linear feet greater than or less than the sum of the base lengths of each pier size. Additional penetration in the bearing stratum greater than the specified penetration shall not be included in determination of increases or decreases of pier lengths related to adjustments in the Contract.

1.4 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Indicate dimensioned plan layout, dowel and anchor bolt setting plans including templates, drilled pier shaft sizes, casing sizes, bell bottom sizes, and top elevation, and details of reinforcing steel.

B. Submittals for Information:

1. Pier Drilling Log: Report of drilled concrete pier construction including actual elevations of top and bottom of each pier, deviations of pier centerline and plumbness, shaft size, bell size, presence of water, use of temporary casing, placement of concrete, and time of start and finish of excavation

C. Product Data: For each type of product indicated.

D. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Laboratory Test Reports: For evaluation of concrete materials and mix design.

E. Welding certificates.

F. Qualification Data: For Installer, land surveyor, and testing agency.

G. Record drawings at Project closeout according to Division 1 Section "Closeout Procedures."

1.5 QUALITY ASSURANCE

A. Installer: Company specializing in performing the work of this Section with minimum three projects in similar soil and rock conditions, and with similar shaft sizes, depths, and quantities.

B. Drilled-Pier Standard: Comply with provisions in ACI 336.1, "Reference Specifications for the Construction of Drilled Piers," unless modified in this Section.

C. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled

pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

D. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E 548.

E. Trial Drilled Pier: Construct trial drilled pier of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as drilled piers located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

1. Install reinforcement, fill with concrete, remove temporary casings, and terminate trial drilled pier 24 inches below subgrade and leave in place.

2. If Architect determines that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.

1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Site Information: A geotechnical report has been prepared for this Project and is included elsewhere in the Project Manual for information only.

1. Information regarding site conditions is provided for the convenience of the Contractor and is not a warranty that the information represents site conditions that may be encountered. The Owner shall not be responsible for interpretations or conclusions drawn from the information provided by the Contractor.

2. Additional borings or other exploratory work may be conducted by the Contractor at no cost to the Owner.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Plain-Steel Wire: ASTM A 82, as drawn.

D. Bar Supports: Furnish spacers to maintain required concrete cover to sides and bottom of excavation.

1. Shaftspacer Systems, Foundation Technologies, Inc., Tucker, Georgia.

2. "Centraligner" and "Hijacker", Pieresearch, Arlington, Texas.

2.2 CONCRETE MATERIALS

A. Provide concrete materials in accordance with Division 3 “Cast-in-Place Concrete.”

2.3 STEEL CASINGS

A. Steel Pipe Casings: ASTM A 283/A 283M, Grade C; or ASTM A 36/A 36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

B. Corrugated-Steel Pipe Casings: ASTM A 929/A 929M, steel sheet, zinc coated.

2.4 SLURRY

A. Slurry: Pulverized sodium bentonite, pulverized attapulgite, or polymers, mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.

2.5 CONCRETE MIX

A. Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases.

1. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).

2. Minimum Slump: Capable of maintaining the following slump until completion of placement:

a. 4 inches for dry, uncased.

b. 6 inches for temporary-casing drilling method.

c. 7 inches for slurry displacement method.

3. Do not air entrain concrete for drilled piers.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

D. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] [0.30] percent by weight of cement.

E. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval of proposed changes to concrete-mix proportions.

2.6 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. Do not add water to concrete mix after mixing.

2. Maintain concrete temperature to not exceed 95 deg F.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavation is unclassified and includes excavation to bearing elevations regardless of character of materials or obstructions encountered.

1. Obstructions: Unclassified excavation includes removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions.

2. Obstructions: Removal of unanticipated boulders, concrete, masonry, or other unforeseen obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work, will be paid according to Contract provisions for changes in the Work.

B. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations, as follows:

1. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, and underreaming equipment attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.

2. Special excavation includes excavation that requires special equipment or procedures above or below indicated depth of drilled piers where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.

a. Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.

b. Earth seams, rock fragments, and voids included in rock excavation area will be considered rock for full volume of shaft from initial contact with rock.

3. Obstructions: Removal of unanticipated boulders, concrete, masonry, or other unforeseen obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work, will be paid according to Contract provisions for changes in the Work.

C. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

D. Excavate shafts for drilled piers to indicated diameters and elevations. Remove loose material from bottom of excavation.

1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.

2. Remove water from excavated shafts before concreting.

E. Notify and allow Owner's testing and inspecting agency to test and inspect bottom of excavation prior to placing reinforcement and concrete. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.

1. Do not excavate shafts deeper than elevations indicated, unless approved by Architect.

2. Additional authorized excavation will be paid according to Contract provisions for changes in the Work.

F. Excavate shafts for closely spaced drilled piers and those occurring in fragile or sand strata, only after adjacent drilled piers are filled with concrete and allowed to set.

G. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.

1. Excavate and complete concreting of drilled pier on same day, if possible, or redrill, clean, and test slurry in excavation before concreting.

2. Clean bottom of each shaft before concreting.

H. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

I. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. Maximum Variation From Vertical: One percent of length.

2. Maximum Variation From Design Top Elevation: Plus 1 inch to minus 3 inches.

3. Maximum Out-of-Position: One twenty-fourth of the shaft diameter or 3 inches, whichever is less.

4. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding .

J. Inspection: Each drilled pier must be inspected and tested by Owner's testing and inspecting agency before placing concrete.

1. Provide and maintain facilities with equipment required for testing and inspecting excavations. Cooperate with testing and inspecting personnel to expedite the Work.

2. Notify Architect and testing agency at least six hours before excavations are ready for tests and inspections.

3.3 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover to reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.

1. Concrete shall be placed within the time limit stated on the Drawings.

2. A construction joint in the pier will not be allowed. if concrete placement is delayed more than one hour. Level top surface of concrete.

B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

1. Where concrete cannot be directed down shaft without striking reinforcing, place concrete with chutes, tremies, or pumps. Use tremies where a drop of more than 25’-0” is required.

2. Vibrate top 60 inches (1500 mm) of concrete.

C. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 60 inches (1500 mm) into concrete, and flow of concrete is continuous from bottom to top of drilled pier.

D. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch (1500 mm) head of concrete above bottom of casing.

1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

E. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

F. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

G. When hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no greater than 95 deg F.

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled piers.

B. A drilled-pier report will be prepared by Owner's testing and inspecting agency for each drilled pier as follows:

1. Actual top and bottom elevations.

2. Description of soil materials.

3. Description, location, and dimensions of obstructions.

4. Final top centerline location and deviations from requirements.

5. Variation of shaft from plumb.

6. Shaft excavating method.

7. Levelness of bottom and adequacy of cleanout.

8. Ground-water conditions and water-infiltration rate, depth, and pumping.

9. Description, diameter, and top and bottom elevations of temporary or permanent casings.

10. Description of soil or water movement, sidewall stability, loss of ground, and means of control.

11. Date and time of starting and completing excavation.

12. Inspection report.

13. Position of reinforcing steel.

14. Concrete placing method, including elevation of consolidation and delays.

15. Elevation of concrete during removal of casings.

16. Remarks, unusual conditions encountered, and deviations from requirements.

17. Concrete testing results.

C. Concrete: Sampling and testing of concrete for quality control may include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94/C 94M.

    a. Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.

    b. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive-strength specimens.

    c. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens, unless field-cured test specimens are required.

    d. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier, but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and one specimen will be retained in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.

4. Strength level of concrete will be considered satisfactory if averages of sets of 3 consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

5. Test results will be reported in writing to Architect, structural engineer, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests will contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in drilled pier, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

6. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as sole basis for acceptance or rejection.

7. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.

    a. Continuous coring of drilled piers may be required, at Contractor's expense, when temporary casings have not been withdrawn within specified time limits or where observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

3.6 DISPOSAL OF MATERIALS

A. Remove surplus excavated material and slurry and legally dispose of it off Owner's property.

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SECTION 32 1313
CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.02 RELATED REQUIREMENTS

A. Section 03 1000 - Concrete Forming and Accessories.

B. Section 03 2000 - Concrete Reinforcing.

C. Section 03 3000 - Cast-in-Place Concrete.

D. Section 07 9005 - Joint Sealers: Sealant for joints.

E. Section 09 9113 - Exterior Painting: Pavement markings.

F. Section 31 2200 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.

G. Section 32 1416 - Brick Unit Paving.

H. Section 33 0513 - Manholes and Structures: Manholes, including frames; gutter drainage grilles, covers, and frames for placement by this section.

1.03 PRICE AND PAYMENT PROCEDURES

1.04 REFERENCE STANDARDS

A. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).

B. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.

C. ACI 305R - Hot Weather Concreting; 2010.

D. ACI 306R - Cold Weather Concreting; 2010.

E. ASTM A185/A185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.

F. ASTM A497/A497M - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.

G. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.

H. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2013.

I. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.

J. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.

K. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.

L. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2014.

M. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a.

N. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.

O. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2013.

P. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.

Q. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2014.

R. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2004 (Reapproved 2013).

S. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2013).

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on joint filler, admixtures, and curing compound.

C. Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

A. Comply with applicable requirements of ACI 301.

B. Concrete Sidewalks : 3,000 psi 28 day concrete, 5 inches thick, buff color Portland cement, refer to landscape architect for finish.

C. Fire Lane/Service Drives: 3,500 psi 28 day concrete, 6 inches thick, #3 Rebar at 18" o.c.e.w. , refer to landscape architect for finish.

2.02 FORM MATERIALS

A. Form Materials: As specified in Section 03 1000, conform to ACI 301.

B. Silicon Joint Filler as approved by Engineer.

C. Wood form material, profiled to suit conditions.

2.03 REINFORCEMENT

A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 2000.

B. Reinforcing Steel: ASTM A615/A615M, Grade 80 (80,000 psi) yield strength; deformed billet steel bars; unfinished.

C. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.04 CONCRETE MATERIALS

A. Obtain cementitious materials from same source throughout.

B. Concrete Materials: As specified in Section 03 3000.

C. Concrete Materials: Provide in accordance with State of Texas Highways standards.

D. Cement: ASTM C150/C150M, Normal - Type I Portland cement, gray color.

E. Fine and Coarse Mix Aggregates: ASTM C33/C33M.

F. Air-Entraining Admixtures: ASTM C260/C260M.

2.05 ACCESSORIES

A. Acid Etch Solution: Muriatic type mixed to a concentration recommended by ACI percent solution.

B. Liquid Surface Sealer: as approved by Engineer.

2.06 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.

C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Concrete Properties:
   1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 3500 psi.
   2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
   3. Calcined Pozzolan Content: Maximum 10 percent of cementitious materials by weight.
   4. Silica Fume Content: Maximum 5 percent of cementitious materials by weight.
   5. Cement Content: Minimum 810 lb per cubic yard.
   6. Water-Cement Ratio: Maximum 40 percent by weight.
   7. Total Air Content: 4 percent, determined in accordance with ASTM C173/C173M.
   8. Maximum Slump: 3 inches.
   9. Maximum Aggregate Size: 1 inch.

2.07 MIXING

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

A. See Section 32 1123 for construction of base course for work of this Section.

B. Prepare subbase in accordance with State of Texas Highways standards.

3.03 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.04 REINFORCEMENT

A. Place dowels to achieve pavement and curb alignment as detailed.

B. Provide doweled joints 12 inch on center at transverse joints.

3.05 PLACING CONCRETE

A. Ensure reinforcement, inserts, embedded parts, formed joints and ____ are not disturbed during concrete placement.

B. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

C. Place concrete to the specified pattern.

3.06 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
   1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
   2. Secure to resist movement by wet concrete.

C. Provide scored joints.
   1. At 3 feet intervals.
   2. Between sidewalks and curbs.
   3. Between curbs and pavement.

D. Provide keyed joints as indicated.

E. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.07 JOINT SEALING

A. Silicone Joint Sealant Required

3.08 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B. Maximum Variation From True Position: 1/4 inch.

3.09 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.
   1. Provide free access to concrete operations at project site and cooperate with appointed firm.
   2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
   3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
   1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
   2. Perform one slump test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.10 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

C. Do not permit pedestrian traffic over pavement until 75 percent design strength of concrete has been achieved.

3.11 SCHEDULES

A. shop drawing submittal for mix design, joint patterns, joint fillers and all other materials required for construction: _____.

END OF SECTION

SECTION 32 14 13 - UNIT PAVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete paver units
B. Bedding and joint sand.

1.03 REFERENCES

A. American Society of Testing and Materials (ASTM):

1. C 33, Specification for Concrete Aggregates.
2. C 136, Method for Sieve Analysis for Fine and Coarse Aggregate.
3. C 140, Sampling and Testing Concrete Masonry Units.
4. C 144, Standard Specification for Aggregate for Masonry Mortar.
5. C 936, Specification for Solid Interlocking Concrete Paving Units.
6. C 979, Specification for Pigments for Integrally Colored Concrete.
7. D 698, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5-lb (2.49 kg) Rammer and 12 in. (305 mm) drop.
8. D 1557, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (4.54 kg) Rammer and 18 in. (457 mm) drop.

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in the manufacture of concrete interlocking pavers for a minimum of five (5) years.

B. Installation shall be by a contractor and crew with at least five (5) years of experience in placing interlocking concrete pavers on projects of similar nature or dollar cost.

C. Installation Contractor shall conform to all local, state/provincial licensing and bonding requirements.

1.05 SUBMITTALS

A. Submit product drawings and data.
B. Submit full size sample sets of concrete paving units to indicate color and shape selections. Color will be selected by GC/SSP from manufacturer’s available colors.
C. Submit sieve analysis for grading of bedding and joint sand.
D. Indicate layout, pattern, and relationship of paving joints to fixtures and project formed details.
E. Substitutions: Substitutions shall be submitted 7 days prior to bid opening for acceptance.

1.06 MOCK-UPS

A. Install a 4 ft. x 4 ft. paver area as described in Article 3.02. This area will be used to determine surcharge of the bedding sand layer, joint sizes, lines, laying pattern(s), color(s), and texture of the job. This area shall be the standard from which the work will be judged. Consideration shall be given with regard to differences in age of materials from time of mock-up erection to time of actual product delivery.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by fork lift or clamp lift. Unload pavers at job site in such a manner that no damage occurs to the product.
B. Sand shall be covered with waterproof covering to prevent exposure to rainfall or removal by wind. The covering shall be secured in place.
C. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.

1.08 MAINTENANCE/WARRANTY

A. Maintenance Requirements: Maintain the work of this Section for one year after 'substantial completion' and until final written acceptance by Owner. Notify the owner in writing of 'substantial completion'. Maintenance period begins after owner's written acceptance of 'substantial completion'.

B. Maintenance Service: Perform the following maintenance operations:
C. Re-sand all joints and gaps in pavers as required or requested by owner. Use polymeric sand to fill all joints.

1. Re-level pavers as required or requested by owner.
2. Control/eradicate any weed or vegetative growth within paver areas.

PART 2 PRODUCTS

2.01 CONCRETE PAVERS

B. Concrete pavers shall be supplied by Pavestone Company or approved equal.
San Antonio, TX: 512.558.7283

C. Pavers shall be Pavestone - "City Stone Series" – Pattern to be 'Random', thickness to be 60mm (2 3/8") and overall dimensions shall be:

Field:
1. City Stone I – 6"x12"
2. City Stone II – 6"x9"
3. City Stone III – 12"x12"

Banding:
1. City Stone III – 12"x12"

D. Paver colors shall be*: Field to 50-50 mix, Light Brown and Tan – Banding to be Dark Brown*

E. Pavers shall meet the following requirements set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units:
1. Average compressive strength of 8,000 psi (55 MPa) with no individual unit under 7,200 psi (50 MPa).
2. Average absorption of 5% with no unit greater than 7% when tested in accordance with ASTM C 140.
3. Resistance to 50 freeze-thaw cycles when tested in accordance with ASTM C 67.

F. Pigment in concrete pavers shall conform to ASTM C 979.
G. Material shall be manufactured in individual layers on production pallets.
H. Materials shall be manufactured to produce a solid homogeneous matrix in the produced unit.

2.02 VISUAL INSPECTION

A. All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction.

2.03 SAMPLING AND TESTING

A. Manufacturer shall provide access to lots ready for delivery to the Owner or his authorized representative for testing in accordance with ASTM 936-82 for sampling of material prior to commencement of paver placement.
B. Manufacturer shall provide a minimum of three (3) years testing backup data showing manufactured products that meet and exceed ASTM 936-82 when tested in compliance with ASTM C-140.
C. Sampling shall be random with a minimum of nine (9) specimens per 20,000 sq. ft. per product shape and size with repeated samples taken every additional 20,000 sq. ft. or a fraction thereof.
D. Test units in accordance with ASTM for compressive strength, absorption and dimensional tolerance. A minimum of three (3) specimens per test required for an average value. Testing of full units is preferred.

2.04 REJECTION

A. In the event the shipment fails to conform to the specified requirements, the manufacturer may sort it, and new test units shall be selected at random by the Owner from the retained lot and tested at the expense of the manufacturer. If the second set of test units fails to conform to the specified requirements, the entire lot shall be rejected.

2.05 EXPENSE OF TESTS

A. The expense of inspection and testing shall be borne by the Owner.

2.06 BEDDING AND JOINT SAND

A. Bedding and joint sand shall be clean, non-plastic, free from deleterious or foreign matter. The sand shall be natural or manufactured from crushed rock. Limestone screenings or stone dust shall not be used.

B. Grading of sand samples for the bedding course and joints shall be done according to ASTM C 136. The bedding sand shall conform to the grading requirements of ASTM C 33 as shown in Table 1 below.

Table 1

Grading Requirements for Bedding Sand

ASTM C 136

Sieve Size	Percent Passing
3/8 in. (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (600 µm)	25 to 60
No. 50 (300 µm)	10 to 30
No. 100 (150 µm)	2 to 10

Bedding sand may be used for joint sand for the initial filling of joints but must be supplemented with polymeric sand or gel to completely fill the joints. If joint sand other than bedding sand is used, the gradations shown in Table 2 are recommended. Joint sand should never be used for bedding sand.

C. The joint sand shall conform to the grading requirements of ASTM C 144 as shown in Table 2 below:

Table 2	
Grading Requirements for Joint Sand	
ASTM C 144 Natural Sand	
Sieve Size	Percent Passing
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	95 to 100
No. 16 (1.18 mm)	70 to 100
No. 30 (600 µm)	40 to 75
No. 50 (300 µm)	10 to 35
No. 100 (150 µm)	2 to 15
No. 200 (75 µm)	0

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subgrade preparation, compacted density and elevations conform to the specifications. Compaction of the soil subgrade to at least 95% Standard Proctor Density per ASTM D 698 is recommended. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils. Owner/SSP Design will inspect subgrade preparation, elevations, and conformance to specifications.
B. Verify that aggregate base materials, thickness, compaction, surface tolerances, and elevations conform to the civil engineers grading plans and specifications.
C. Verify location, type, installation and elevations of edge restraints around the perimeter area to be paved.
D. Verify that base is dry, uniform, even, and ready to support sand, pavers, and imposed loads.
E. Beginning of bedding sand and paver installation means acceptance of base and edge restraints.

3.02 INSTALLATION

A. Refer to Engineer’s plans for sub-base preparation, concrete work and final grades/elevations.
B. Apply herbicide on any vegetative matter within paver areas.
C. Apply pre-emergent herbicide to base course prior to installing leveling sand.
D. Spread sand evenly over the base course and screed to a nominal 1 in. thickness, not exceeding 1-1/2 in. thickness. The screeded sand should not be disturbed. Place sufficient sand to stay ahead of the laid pavers. Do not use the bedding sand to fill depressions in the base surface.
E. Ensure that pavers are free of foreign materials before installation.
F. Lay the pavers in pattern as indicated on plans using specified paver types. Maintain straight pattern lines as indicated on plans or details. Paving banding pattern shall be installed as indicated on plans or details.
G. Joints between pavers shall not exceed 3/16” in width. Miter cut pavers shall be used to minimize gaps and joints.
H. Fill gaps at the edges of the paved area with cut pavers or edge units.
I. Cut pavers to be cut/sawn using a masonry saw. Paver splitters shall not be used.
J. Use a low amplitude, high frequency plate vibrator to vibrate the pavers into the sand. Use Table 3 below to select size of compaction equipment:

Table 3

Paver Thickness	Minimum Centrifugal Compaction Force
60 mm	3000 lbs. (13 kN)
80 mm	500 lbs (22 kN)

K. Vibrate the pavers, sweeping polymeric sand into the joints and vibrating until they are fully compacted. This will require at least two or three passes with the vibrator. Do not vibrate within 3 ft. (1 m) of the unrestrained edges of the paving units.
L. Install 'hidden' concrete edge restraints as shown on details using Min. 2500 PSI concrete with fibre-mesh reinforcement.
M. All work to within 3 ft. (1 m) of the laying face must be left fully compacted with sand-filled joints at the completion of each day.
N. Sweep off excess sand when the job is complete.
O. The final surface elevations shall not deviate more than 3/8 in. (10 mm) under a 10 ft. (3 m) long straightedge.
P. The surface elevation of pavers shall be 1/8 in. to 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.
Q. The re-sanding of paver joints using polymeric sand shall be accomplished by contractor for a period of one (1) year after completion of work.

3.03 FIELD QUALITY CONTROL

A. After removal of excess sand, check and adjust final elevations for conformance to the grading and drainage plans.

END OF SECTION 32 14 13

SECTION 328000 - IRRIGATION

PART 1 - GENERAL

1.1 SCOPE

A. An automatic underground irrigation system for exterior landscaped areas including, but not limited to, supply an installation of water meter, backflow device and controller, boring and sleeving, rotary heads and spray heads in lawn areas and spray heads and drip lines in shrub, ground cover, and flower bed areas.

NOTE: This project is being constructed on and around an existing school landscape and irrigation system. Contractors shall protect existing irrigation system and provide temporary bypasses, re-routing, etc. as required to keep system operational throughout construction. Any damage whatsoever to existing irrigation system shall be repaired and replaced at contractor's expense.

1.2 SYSTEM DESCRIPTION

A. General:
   1. This project includes re-routing of existing irrigation mainlines, connections to existing mainlines, relocating valves and equipment and making adjustments and repairs to existing irrigation components.

B. Design Requirements:
   1. Provide connection to water source (existing mainline) and new water meters as specified and in accordance with local code requirements.
   2. Provide for an electro-mechanical controller.

C. Performance Requirements: Provide for irrigation at a rate of 1 in. per week applied at 2 or 3 day intervals.

1.3 QUALIFICATIONS

A. Irrigation work to be performed by a Texas licensed irrigation company specializing in commercial irrigation installation with a minimum of five (5) years experience on similar projects. Owner/SSP Design to review qualifications and approve subcontractor prior to commencing work.

1.4 SUBMITTALS

A. Submittals shall be formatted electronically in a PDF file with a table of contents and tabs identifying each section. The following submittals are required for this section:
   1. Product Data: Manufacturers' technical data (Cut Sheets) and installation information for all components including: Backflow Assembly (Pressure Vacuum Breaker PVB or Reduced Pressure, Backflow Preventer RPZ (as specified), Y strainer (if required), Ball valves, PVC pipe, PVC fittings, PVC primers, solvents, cement, glue, etc., Control wire / tracking wire, Wire connectors, Pump stations, booster pumps (if specified), Pump enclosures (if specified), Controller (incl. communications modules, etc.), Rain/freeze sensors, Valves, Valve boxes, Decoders (if specified), Rotors, Sprays, Nozzles, Bubblers, Drip line, Drip filters, Drip indicators (operind), Air relief valves

1.5 QUALITY CONTROL

A. Submit verification of water pressure at meter or point of connection.

1.6 MAINTENANCE/WARRANTY

A. Provide the following extra materials to the Owner:
   1. Two (2) quick coupler hose bib keys.

2. Four (4) keys for the controller door lock.

B. Maintenance Requirements: Maintain the work of this Section for ninety days after 'substantial completion' and until final acceptance by Owner. Notify the owner in writing of 'substantial completion'. Maintenance period begins after owner's acceptance of 'substantial completion'.

C. Maintenance Service: Perform the following maintenance operations at least once a week:
   a. Test entire system and adjust timer as necessary and as directed by landscape contractor, landscape designer or owner.
   b. Replace or repair any broken parts or equipment.
   c. Report any significant problems in writing to landscape contractor, owner and landscape designer.

D. Warranty: Warranty shall cover all parts and equipment for a period of one year from the date of final acceptance. Repairs and replacements shall be completed within two weeks of notification from owner.

PART 2- PRODUCTS

2.1 MATERIALS

A. PVC Plastic Pipe: ASTM D 2241-83, SDR21, class 160 lateral piping; ASTM D1785, class 200 mainline piping.

B. Pipe Fittings:
   1. Pipe under 3 in., id: Socket type, ASTM D 2466-78, with solvent Cement, ASTM D 2564-80.
   2. Pipe 3 in. id and Larger: Gasketed fittings of epoxy coated steel with non-hardening pipe dope or Teflon tape for threads.

C. Concrete: 2500 psi min. compressive strength.

2.2 MANUFACTURED UNITS

A. Controller: Electro-mechanical, 24 hr./14-day clock with manual operation capacity, with adequate number of stations for system operating requirements (two wire) (see irrigation equipment table). Provide both freeze-protection and rain-sensor devices with controller. Provide ground-fault interrupt and lightning protection. Provide flow control, ET Management, and IQ System. Contractor to coordinate setup and connection to IQ software including training.

B. Water Meters: Water meters in locations shown on plans. Contractor to coordinate application, permit and installation with local utility company. Contractor responsible for water meters and all associated installation costs.

C. Booster Pump: If required contractor shall furnish and install booster pump with enclosure as specified in plans/details. Contractor shall also provide a concrete pad and any and all fittings, adaptors, connections, enclosure, etc. for the complete installation and proper operation of booster pump.

D. Backflow Preventers: Provide and install backflow devices per local codes, specifications and requirements. Provide steel mesh enclosure per plans/schedule.

E. Electric Valves: Normally closed, 24v AC, 60 cycle, solenoid actuated, globe pattern, diaphragm type. Cast brass or plastic body and nylon reinforced nitrile rubber diaphragm.

F. Quick coupling Valves: Cast brass body with self-closing cover. Provide (2) brass keys with

1 in. female threaded outlet.

G. Sprinkler Heads: Heavy-duty plastic sprinkler case, high density plastic sprinkler body, corrosion-resistant internal parts, plastic spray nozzles with adjustable flow and direction features.

H. Control Wire: 24v UL/UF., approved for direct burial. Provide color-coded wire with white used for common (14-gauge, single-strand copper) and red for control (14-gauge single-strand copper).

I. Tracking Wire: 18 gauge copper (only where mainline and wiring bundle are separated)

J. Valve Boxes: Heavy-duty commercial grade, fiberglass reinforced, plastic with locking covers. Rainbird/Hunter/Approved Equal VB series, 10” Round or Standard Rectangular Min. or apprvd equal.

K. Swing Joints: 3 high density polyethylene street ells with 8 in. Schedule 80 PVC nipple; sized the same as inlet to sprinkler head.

L. Sleeves: Schedule 40 PVC. Boring as required under all existing pavement, walls or curbs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine the site and conditions under which irrigation work is to be performed. Irrigation contractor shall notify the landscape contractor in writing, with a copy to Construction Manager, if the site is unsatisfactory. Do not begin the work until unsatisfactory conditions have been corrected in a manner acceptable to irrigation contractor. Beginning of work indicates acceptance of the site as satisfactory by the irrigation contractor.

3.2 INSTALLATION

A. General: Install tracking wire along mainline pipe if separate from valve wiring bundle.

B. Excavating and Filling:
1. Cover for Piping:
    a) Mains: 18 in. min.
    b) Laterals: 12 in. min.
2. Use clean backfill material without stones larger than 1/2 in., debris or extraneous material that may damage pipe assembly.
3. Compact all trenches to a minimum 95% Standard Proctor Density.

C. Pipe:
1. Install in existing sleeves under pavement or provide boring and sleeves under pavement as required.
2. Clean pipe and joints before making connections. Purple primer to be used on all joints before applying solvent. Per TCEQ Regulations.
3. Attach joints according to manufacturer's instructions. Threaded joints to be coated with "Teflon" tape. Allow joints to set for at least 24 hrs. before applying water pressure to the system.
4. Thoroughly flush piping before sprinkler heads are installed and test under pressure for leaks in each line separated by valves.

D. Water Meters: Provide and install water meters per local codes, specifications and requirements. Coordinate permit and application with owner and local utility company. Adjust locations as necessary to coordinate with existing water line locations.

E. Back Flow Protection: Provide and install backflow devices per local codes, specifications and requirements including enclosure.

F. Valves:
1. Provide isolation valve on inlet side of every electric control valve (if specified).
Install electric and gate valves with at lest 10 in. of cover over the valve and at least 6 in. of cover over the stem.
2. Install valve box centered over the flow control handle. Provide 1 cu. ft. of clean pea gravel in the bottom of each valve box with filter fabric below.
3. In lawn areas, valve boxes to be set flush with existing grade; in planting bed areas valve boxes shall be set 2" above grade.

G. Controllers: Hard wire to nearest power source and CAT6 data line. Coordinate with general contractor. Install on exterior wall in location as shown on plans or as directed/approved by Owner / SSP.

H. Sprinkler Heads: Install all heads on swing joint assemblies and flush with finish grade.

I. Wiring:
1. Bundle and tape wires at 10 ft. o.c., max.
2. Snake wire in trenches to allow for expansion. Provide expansion coils at 100 ft. o.c. max., and at the entry to each valve box.
3. Splice wires using mechanical sealant connector for a waterproof connection. Make all wire splices within valve boxes. Use RB WPCONN N90300 or approved equal.

3.3 FIELD QUALITY WORK

A. General: Notify the Construction Manager at least 48 hours before testing is begun.
B. Hydrostatic Test: Test mainline piping to a hydrostatic pressure of not less than 100 psi for a minimum of 24 hours. Piping may be tested in sections to expedite work. Remove and repair piping and connections which do not pass hydrostatic testing.
C. Operational Testing: Perform operational testing after hydrostatic testing is completed, backfill is in place, and sprinkler heads adjusted to final position.

3.4 ADJUSTING

A. Check sprinkler heads for arc of spray. Adjust as necessary to provide 100% coverage of all landscaped areas.
B. Adjust layout to conform to actual layout of landscape plantings.

3.5 DEMONSTRATION

A. Demonstrate operation of the system to Owner's personnel and staff.

3.6 CLOSE-OUT DOCUMENTS

A. As-Built Drawings: Submit 'As-Built' drawings before project close-out showing the irrigation system layout, including line locations and sizes, spray heads and types, points of connection, booster pump, location of backflow device(s), controller, and other installation information.
B. Warranty Letters: Submit warranty letters for all irrigation items including labor for the specified warranty period.
C. Operation and Maintenance Data: Submit Manufacturers' operation and maintenance instructions and laminated colored (11x17) valve Zoning Diagram.

END OF SECTION 32 80 00

SECTION 329000 - PLANTING

PART 1 - GENERAL

1.1 SCOPE

A. Supply and installation of all approved materials, labor, equipment, transportation and services required and incidental thereto, in conformity with the plans and specifications, including but not limited to; vegetation protection/pruning, fine grading, earth mounding, bed excavation and preparation, bed edging, planting soil/compost mixes, fertilizer, mulch, trees, palms, shrubs, ground covers, staking, paving, site furniture, clean-up, maintenance, and warranty.

NOTE: This project is being constructed on and around an existing school and landscape. Contractors shall protect existing landscape, trees, shrubs, groundcovers, lawns, etc. Any damage whatsoever to existing landscape shall be repaired and replaced at contractor's expense.

B. Related Sections:
   1. Irrigation – 328000
   2. Lawns – 329200

1.2 REFERENCE STANDARDS

A. General: "Hortus Third," 1976.

B. Texas Association of Nurserymen, Grades and Standards for Nursery Stock.

C. Plant Material: "American Standard for Nursery Stock," ANSI Z60.1-1990.

D. National Arborist Association Standards

1.2 DEFINITIONS

A. Specimen Plants: Plants having exceptional character, superiority in form and branching, and the best attributes of the species; all as determined by the Architect, Landscape Designer or Owner.

1.3 QUALIFICATIONS

A. Landscape work to be performed by a single firm specializing in commercial landscape work with a minimum of five (5) years experience on similar type projects. Owner/SSP Design to review qualifications and approve subcontractor prior to commencing work.

1.4 SUBMITTALS

A. Submittals shall be formatted electronically in a pdf file with a table of contents and tabs identifying each section. The following submittals are required for this section:
   1. Landscape Construction Sequence
   2. Edging Materials
   3. Post emergent Herbicides
   4. Pre emergent Herbicides
   5. Soils, Compost and Mulch
   6. Sources of all Plant Materials (including address and telephone numbers)
   7. Product Data Material Safety Data Sheets
   8. Paving Materials
   9. Staking Materials

10. Samples: One foot sections of edging (as specified on plans), one pound bag sample of each; topsoil, premium compost, mulch, decomposed granite, river rock, washed gravel and example boulder/rocks.
11. Photographs of all plant material prior to ordering/installation
12. Name and License Number of Subcontractor for pruning trees (Certified I.S.A. Arborist required)

1.5 PROTECTION

A. Before commencing work, contractor shall place orange construction fencing around all vegetation labeled “to remain” on landscape plans. Fencing shall be placed squarely around each tree 6’ x 6’ and at least 60” in height or continuously around groups of vegetation as shown on plans. No work may begin until this requirement is fulfilled. All other vegetation not labeled “to remain” shall be cleared and grubbed including root systems.

B. In order to avoid damage to roots, bark or lower branches, no truck or other equipment shall be driven or parked within the drip line of any tree, unless the tree overspreads a paved way.

C. The contractor shall use any and all precautionary measure when performing work around trees, walks, pavements, utilities, and any other features either existing or previously installed under this Contract.

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:

a. 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.

b. RAISING GRADES: When the existing grade at tree is below the now finished grade, and fill not exceeding 16 inches (16") is required, clean, washed gravel graded from one to two inches (1" - 2") in size shall be placed directly around the tree trunk. The gravel shall extend out from trunk on all sides a minimum of 18 inches (18") and finish approximately two inches (2") above the finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with the trunks of any trees requiring fill. Where fill exceeding 16 inches (16") is required, a dry laid tree well shall be constructed around the trunk of the tree. The tree well shall extend out from the trunk on all sides a minimum of three feet (3') and to three inches (3") above finish grade. Coarse grade rock shall be placed directly around the tree well extending out the drip line of the tree. Clean, washed gravel graded from one to two inches (1" - 2") in size shall be placed directly over the coarse rock to a depth of three inches (3"). Approved backfill material shall be placed directly over the washed gravel to desired finished grade.

c. LOWERING GRADES: Existing trees in areas where the now finished grade is to be lowered shall have regarding work done by hand to elevation as indicated. Roots as required shall be cut cleanly three inches (3") below finished grade and scars covered with tree paint.

d. Trees marked for preservation that are located more than six inches (6") above proposed grades shall stand on broad rounded mounds and be graded smoothly into the lower level. Trees located more than 16 inches (16") above proposed grades shall have a dry laid stonewall, or other retaining structure as detailed on the plans, constructed a minimum of five feet (5') from the trunk. Exposed or broken roots shall be cut clean and covered with topsoil.

F. Contractor is responsible for all protection measures listed above. If these procedures are not followed, contractor is responsible for replacement of existing trees with approved trees of equal caliper and height.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Transport plant materials covered or in closed vehicles to protect from exposure to heat and wind. Spray trees and in full leaf with anti-desiccant - as recommended by the manufacturer - before shipping. Take precautions to protect plant materials from desiccation and from damage to bark, branches and roots. Do not allow root balls to crack. Schedule shipments to coincide with planting work schedule.

B. Storage and Protection: If planting is delayed after delivery, keep plants in a shaded area, cover roots with mulch or topsoil, and keep plants constantly watered until planted.

1.7 MAINTENANCE/WARRANTY

A. Maintenance Requirements: Maintain the work of this Section throughout construction and for ninety days after 'substantial completion' and until final written acceptance by Owner. Notify the owner in writing of 'substantial completion'. Maintenance period begins after owner's written acceptance of 'substantial completion'.

B. Maintenance Service: Perform the following maintenance operations at least once a week:
   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 2 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. Irrigation:
      a) If the irrigation system is operating, program and monitor the system to provide adequate water for plants.
      b) If the irrigation system is not operating, hand water plants. Deep water trees each week.
   5. Dispose of all maintenance debris/clippings off-site. Owner's dumpsters shall not be used.
   6. Keep all site areas tidy and free of grass clippings, mulch or other foreign materials.
   7. Submit dates, descriptions and receipts of all maintenance operations to SSP Design for approval.

C. Warranty: Warranty shall cover all shrubs/groundcovers for a period of three months and trees/palms for a period of one year from the date of final acceptance. Any plant material deemed dead or unrecoverable by the owner shall be replaced with similar species and size within two weeks of notification from owner.

1.8 RIGHT OF REJECTION

A. The Owner/SSP Design reserve the right to inspect and reject plants at any time and at any place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fertilizer: 13-13-13 Osmocote slow release fertilizer granules or approved equal.

B. Planting tablets: Agraform 21 gram slow release fertilizer tablets or approved equal.

C. Compost: Premium grade compost ('9 Kids Compost' or approved equal).

D. 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/GC in soil.

A. Mulch:
   1. Shrub and Ground Cover Planting Areas: Grade Grade A Shredded Hardwood; long, fibrous bark strands free from wood chips. Texas Natives or Approved Equal.
   2. Watering basins: Grade A Shredded Hardwood; long, fibrous bark strands free from wood chips. Texas Natives or Approved Equal.

B. Plants:
   1. General: Provide plant materials that are healthy and free from disease, insects, and larvae and without damage to bark, branches, and roots.
   2. Approval: All plants must be approved by Owner/SSP Design prior to installation. Any plants not approved by Owner/SSP Design shall be subject to rejection. All trees/palms must be inspected, approved and tagged by Owner/SSP Design at their place of origin or as directed in writing by Owner/SSP Design. Container grown trees shall be obtained by Glen Flora Farms, Inc. or approved equal.
   3. Sizes: Measured after pruning and in accordance with the plant schedule.
   4. Root Treatment: As follows in accordance with the Reference Standards:
      i. Palms: Balled and burlapped or containerized if they have been in the container for at least one growing season.
      ii. Trees, Shrubs, Ground Cover Plants: Container grown with a well-established fibrous root system.
   5. Palms: All new palms shall be field dug or containerized material in specified sizes shown in plant schedule. 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 - 44" diameter, 36" height
      b) Washingtonia Palms - 44" diameter, 36" height
      c) Cuban Royal Palms, Mediterranean Fan Palms, Cocos Palms - 30" diameter, 30" height

C. Staking material:
   1. Stakes shall be commercial grade T-Posts, 1.25 Gauge, 8' Ht., Green with orange safety caps on tops. Note: Do not drive through stakes through root balls.
   2. Tree ties shall be Poly Chain Lock – 1" width, black, ProLock or approved equal
   1. Stakes shall be commercial grade steel T-Posts per details (do not drive through rootball).

D. Edging:
   1. Concrete Edging: Extruded, colored, fibermesh reinforced concrete edging (per details) *Curb Appeal (or approved equal)*
   2. Tree Rings: 4" Ht., 30" Dia., Black Anodized Aluminum tree rings. *Dreamscapes (or approved equal)*

   3. Aluminum edging: 4" Ht., Black Anodized Aluminum Edging. *Dreamscapes (or approved equal)*

2.2 PLANTING SOILS

A. Planting Mix: 75 percent sandy-loam topsoil; 25 percent premium compost; (3:1 ratio by volume); and specified fertilizer or planting tablets.

B. Shrub and Ground Cover Areas:
1. Where topsoil has been installed: Apply one inch layer in planting bed; till into the top six inches of soil.
2. Where no topsoil has been installed: Remove twelve inches of existing soil and replace with ten inches of 'Planting Mix' as described in Item A above.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine the site and conditions under which landscape work is to be performed. Have the installer notify the Contractor in writing, with a copy to SSP Design if the site is unsatisfactory. Do not begin the work until unsatisfactory conditions have been corrected in a manner acceptable to installer. Beginning of work indicates acceptance of the site as satisfactory by the installer.

3.2 EXECUTION

A. Site Preparation: Contractors must visit and review site prior to bidding. Compacted 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 Owner/SSP Design prior to rough and finished grading operations. Contractor shall not install any fill or topsoil in landscape areas prior to site condition approval by Owner/SSP Design.

B. Drainage: Landscape contractor shall follow grading as shown and specified on Civil Engineer's grading plans. Landscape contractor shall coordinate grading operations with site contractor. Landscape contractor shall ensure final grades conform to the Civil Engineer's grading plan including grades around building, swales, sidewalk under-drains/swales, roof drains, splash blocks and rock swales through planting beds.

C. Vegetation Protection: Contractors are responsible for protection of existing vegetation labeled on plans "to remain". Protection of existing vegetation includes supply and installation of protective fencing around all existing planting areas.

D. Bed Preparation and herbicide: 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.

E. Planting Beds: Excavate 12" of existing soil within planting beds and replace with 8" of imported topsoil and 2" of premium compost. Mechanically till into top six inches of bed until a loose, friable soil condition is met. Final grades within all planting beds shall be 2-3" 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 Construction Manager or the Civil Engineer. Owner or SSP Design to approve planting beds prior to planting operations.

F. Edging: Edging shall be installed as shown on plans. Edging shall allow for tapered drainage points to ensure free drainage away from all structures and walkways. Edging shall be set flush with adjacent paving, sidewalks or driveways.

G. Grass Areas: Scarify, float and fine grade all areas to receive sod or hydromulch for approval by SSP 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 building / planting beds. (see specification on lawns for further requirements).

H. Berms and Mounding: Supply topsoil and construct berms as indicated on plans. Berms shall have a maximum slope of 1:4. Owner or Construction manager to approve berming and mounding prior to planting operations.

I. Planting:

1. Installation:
    a) Excavate planting pit to depth and width indicated on Drawings.
    b) Set root ball on undisturbed or compacted soil in planting pit. Remove burlap, rope, wire, and all other wrapping material from top of ball. Remove any binding rope which is not biodegradable completely.
    c) Fill planting pit 2/3 full with planting mix, soak with water and allow settling, and adding fertilizer tablets as detailed. Finish filling pit with planting mix and tamp lightly.
    d) Construct a watering basin as detailed and install 2 in. of mulch. Water-in to completely saturate the root ball and planting mix. Add planting mix where any settling or air pockets occur.
    e) Stake all trees/palms immediately after planting as detailed.

2. 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 at the appropriate time. All palms must be inspected and approved on site by SSP Design prior to installation.

3. Shrubs: All plants shall be of species denoted on plans and shall be container-grown material at specified sizes. All plants shall be of size equal or greater than T.A.N. standards for their respective container size. All material shall be vigorous, well established, of good form consistent of species, free of disease and insects, with large healthy root systems and with no evidence of being restricted or damaged. All plants shall be inspected and approved on site by SSP Design prior to installation.

4. Planting Holes: All tree/palm holes shall be excavated with a diameter at least two times the rootball size and to a depth equal to the height of the rootball. The bottoms and sides of each hole shall be scarified with a pick to allow for free drainage and maximum root penetration. After tree/palm placement, the hole shall be backfilled with a mixture of excavated soil and premium compost mixture (Earthwise Organics ‘RGV’ Mix or approved equal). All holes shall be tested/inspected by SSP Design for free drainage prior to installation of trees.

5. 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 2 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.

J. Insect and Disease Control: Apply treatment as frequently as required during construction and 90-day maintenance period to prevent damage to plant material. Use only chemicals specifically approved by TNRCC.

K. Pruning: All existing and new vegetation shall be pruned/trimmed by a Certified I.S.A. Arborist as directed on site by SSP Design.

3.3 CLEANUP AND PROTECTION

A. Remove debris from landscaped areas daily and sweep clean adjacent pavements, if soiled by landscape activities.
B. Provide temporary barriers or fences as required to protect landscaping from damage or theft until final acceptance.

3.4 CLOSE-OUT DOCUMENTS

A. As-Built Drawings: Submit ‘As-Built’ drawings before project close-out showing the landscape layout, including revised plant material, and other installation information.

B. Warranty Letters: Submit warranty letters for trees / palms / lawns / shrubs / pavers / / furniture / masonry / stone / amenities.

END OF SECTION 32 90 00

SECTION 329200 - LAWNS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The establishment of a complete and uniform lawn by sodding and/or hydromulching.

B. Related Sections:
   1. Section 328000-Irrigation
   2. Section 329000-Planting

NOTE: This project is being constructed on and around an existing school and landscape. Contractors shall protect existing landscape, trees, shrubs, groundcovers, lawns, etc. Any damage whatsoever to existing landscape or lawns shall be repaired and replaced at contractors' expense.

1.2 QUALIFICATIONS

A. Lawn work to be performed by a single firm specializing in commercial landscape work with a minimum of five (5) years experience on similar type projects. Owner/SSP Design to review qualifications and approve subcontractor prior to commencing work.

1.3 SUBMITTALS

A. Submittals shall be formatted electronically in a pdf file with a table of contents and tabs identifying each section. The following submittals are required for this section:

   1. Product Data: Manufacturer's specifications and application instructions for fertilizer.

   2. Certificates: Inspection certificate from Texas Department of Agriculture indicating sod has been found free of diseases, insects and larvae.

   3. Certificates: Breakdown of seed types, percentages, and mixture composition.

   4. Sod Delivery Tickets: One per truckload indicating sod species, nursery certification, date and time of cutting.

1.4 DELIVERY, STORAGE AND HANDLING

A. Sod Delivery: Have sod delivered within forty-eight hours of cutting. Stack sod with roots to roots, protected from exposure to elements during shipment.

B. Storage: Lay sod as soon a practicable after delivery. If installation is delayed more than four hours, store sod under shade and keep constantly moist. Sod must be laid within forty-eight hours of cutting. Do not pile more than two foot depth of sod. Do not tear, stretch or drop sod. Do not allow soil to break free of turf roots.

1.5 PROJECT CONDITIONS

A. Utility Construction: Do not lay sod or begin hydro-mulching until all underlying utility work is complete, trenches backfilled, compacted and graded, and topsoil placed and fine graded.

1.6 MAINTENANCE/WARRANTY

A. Maintenance Service: Maintain the work of this Section throughout construction and until the Date of Substantial Completion and ninety (90) days thereafter or until a complete and uniform lawn has been established.

1. Establish hydro-mulched or sodded lawns per planting plans. Reapply hydro-mulch or re-sod as necessary until full and uniform coverage is obtained.
2. Mow lawns to maintain height of grass at 2 inches or as directed by SSP Design.
3. Trim/edge all lawn areas adjacent to watering basins, pavements, driveways, walls, structures, curbs, planting beds, edges and islands.
4. Provide insect and disease control to maintain health of grass.
5. Fertilize with commercial grade lawn fertilizer until complete and uniform coverage is obtained.
6. Irrigation:
   a) If the irrigation system is operating, program and monitor the system to provide adequate water for grass.
   b) If the irrigation system is not operating, hand water grass.

B. Warranty: Warranty shall cover all lawn grasses for a period of three months from the date of final acceptance. Final acceptance will not be approved until full and uniform lawns are completely established.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: See Section 02900, Landscaping.

B. Sod: (See schedule for type). Provide premium #1 certified sod grown in a sod nursery on sandy soil, at least 1 yr. old with a heavy top and a strong, well-knit root system, and not more than five percent weeds or foreign grasses.

C. Hydro-mulch mixture: (See schedule for type). Lawn seed mixture shall be shall be fresh, clean new, crop seed. Hydromulch mixture shall be composed of both hulled and unhulled seed with an appropriate percentage of Rye according to season of planting. The Contractor shall furnish to the Landscape Designer or Owner the dealer's guaranteed statement of the composition of the mixture and the percentage of purity and germination of each variety.

D. Fertilizer: 12-4-8 (N-P-K), formulated for slow-release Nitrogen.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine the site and conditions under which this work is to be performed. Have the installer notify the Contractor in writing, with a copy to SSP Design, if the site is unsatisfactory. Do not begin the work until unsatisfactory conditions have been corrected in a manner acceptable to installer. Beginning of work indicates acceptance of the site as satisfactory by the installer.

3.2 PREPARATION

A. Topsoil: Refer to Section 02900 ‘Landscaping’ for topsoil amendment.

B. Site Preparation: Contractors must visit and review site prior to bidding. Compacted 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 SSP Design prior to rough and finished grading operations. Contractor shall not install any fill or topsoil in landscape areas prior to site condition approval by SSP Design.

3.3 INSTALLATION – HYDROMULCH/SEED

A. All exterior ground within the limit of contract or any damaged adjacent areas, except surfaces occupied by structures and paving, except areas indicated to be undisturbed, shall be seeded, hydromulched or planted as shown on drawings. Furnish topsoil, finish grading, prepare seed bed, seed, hydromulch and maintain areas as indicated on the drawings.

B. Lawn Area Preparations - Grade areas to finish grades, filling as needed or removing surplus material. Float all lawn areas to a smooth, uniform grade as indicated on engineers grading plans. All lawn areas shall slope to drain away from structures and planting beds. Where no grades are shown, areas shall have a smooth and continual grade between existing or fixed controls (such as walks, curbs, catch basin, elevational steps or structures) and elevations shown on plans. Contractor to ensure proper drainage around all structures. Adjust grades as necessary to direct water away from structures and planting beds. Report any discrepancies on all drainage issues in writing to SSP Design or the project engineer.

C. Roll, scarify, rake and level as necessary to obtain true, even lawn surfaces. All finish grades shall meet approval of the SSP, before seeding/hydromulching operations. Loosen soil to a depth of six inches (3") in lawn areas by approved method of scarification and grade to remove edges and depressions. Remove stones or foreign matter over one half inch (1/2") in diameter from the top two inches (2") of soil. Float lawn areas to finish grades as shown on civil plans. Install topsoil over prepared subbase if included in materials schedules or as required to allow for a proper seed bed for germination and strong healthy growth.

D. Lawn areas should be permitted to settle or should be firmed by rolling before seeding/hydromulching.

E. Seeding/hydromulching shall not be performed in windy weather.

F. Lawn areas shall be seeded by hydro-mulching evenly with an approved mechanical hydro-mulcher at the rate of a minimum of three (3) pounds per 1,000 square feet. In areas inaccessible to hydro-mulching equipment, the seeded ground shall be lightly raked with flexible rakes and rolled with a water ballast roller. After rolling, seeded areas are to be lightly mulched with wheat straw or approved material.

G. Lawns shall be maintained by the Contractor for at least 90 days after substantial completion or as long as necessary to establish a uniform stand of the specified grasses, or until final acceptance of lawns, whichever is later.

H. Water seeded/hydromulched areas twice the first week to a minimum depth of six inches (6") with a fine spray and once per week thereafter as necessary to supplement natural rain to the equivalent of one inch (1") or to a six-inch (6") depth.

I. The surface layer of soil for seeded/hydromulched areas must be kept moist during the germination period. After first cutting, water as specified above.

J. Make weekly inspections to determine the moisture content of the soil and adjust the watering schedule established by the irrigation system installer to fit conditions

K. After grass growth has started, all areas or parts of areas, which fail to show a uniform stand of grass for any reason whatsoever shall be reseeded/hydromulched in accordance with the plans and as specified herein. Such areas and parts of areas shall reseeded, hydromulched or sodded repeatedly until all area are covered with a satisfactory growth of grass at no additional cost to the Owner.

L. Watering shall be done in such a manner and as frequently as is deemed necessary by SSP to assure continued growth of healthy grass. All areas of the site shall be watered in such a way as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to the finished surface due to the watering equipment.

M. Water for the execution and maintenance of this work shall be provided by the Owner at no expense to the Contractor. The Contractor shall, however, furnish his own portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport the water from the available outlets and apply it to the seeded area in an approved manner.

N. Mowing of the seeded, hydromulched or sodded areas shall be initiated when the grass has attained a height of one and one-half to two inches (1-1/2" to 2"). Grass height shall be maintained between one and one and one-half inches (1' to 1½") at subsequent cutting depending on the time of year. Not more than one third (1/3) of the grass leaf shall be removed at any cutting and cutting shall not occur more than seven (7) days apart.

O. When the amount of grass is heavy, it shall be removed to prevent destruction of the underlying turf. If weeds or other undesirable vegetation threaten to smother the planted species, such vegetation shall be mowed or, in the case of rank growths, shall be uprooted, raked and removed from the area by methods approved by the SSP.

P. Protect seeded/hydromulched areas against trespassing while the grass is germinating. Furnish and install fences, signs, barriers or any other necessary temporary protective devices. Damage resulting from trespass, erosion, washout, settlement or other causes shall be repaired by the Contractor at his expense.

Q. Remove all fences, signs, barriers or other temporary protective devices after final acceptable.

3.4 INSTALLATION – SOD

A. Sod shall be installed to all areas as indicated on plans.

B. Sod Bed Preparation - Grade areas to finish grade, filling as needed or removing surplus dirt, stone, debris, etc. and floating areas to a smooth, uniform grade as indicated on grading plans. All lawn areas are to slope to drain.

C. Sod shall be laid within 48hrs of being cut. Only healthy vigorous growing sod is to be laid.

D. Always lay sod across slope and tightly together so as to make a solid area.

E. Roll or firmly but lightly tamp with suitable wooded or metal tamper all new sod

sufficiently to set or press sod into underlying soil.

F. After sodding has been completed, clean up and thoroughly moisten by sprinkler newly sodded areas.

3.5 FERTILIZING – GRASS

Fertilizer shall be included in the hydromulch mixture. After full germination and or sodding, all lawn areas shall have fertilizer applied in two (2) applications with a thorough watering immediately following application. The first application shall be one (1) week after sodding or full germination at the rate of 5 pounds per 1,000 square feet. The second application shall be done after 60 days at the rate of 3 pounds per 1,000 square feet. Soil analysis and time of year shall be considered with SSP to determine fertilizer type, composition and final application rates . Submit fertilizer type and analysis to SSP for approval before any application. Document fertilizer application with photos and receipts of fertilizer purchases.

3.6 CLEANUP AND PROTECTION

A. Remove debris from landscaped areas daily and sweep clean adjacent pavements, if soiled by landscape activities.

B. Protect lawns from damage, theft or vandalism until final acceptance. Install stakes and flagging or temporary fencing if required to keep traffic off newly established lawn areas

END OF SECTION 32 92 00

SECTION 33 0110.58
DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 1416.

1.02 RELATED REQUIREMENTS

A. Section 33 1416 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS

A. AWWA B300 - Hypochlorites; 2011.

B. AWWA B301 - Liquid Chlorine; 2010.

C. AWWA B302 - Ammonium Sulfate; 2010.

D. AWWA B303 - Sodium Chlorite; 2010.

E. AWWA C651 - Disinfecting Water Mains; 2005.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Test Reports: Indicate results comparative to specified requirements.

C. Certificate: From authority having jurisdiction indicating approval of water system.

D. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.

E. Disinfection report:

F. Bacteriological report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of City of Edinburg.

1.05 QUALITY ASSURANCE

A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.

B. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of Texas.

PART 2 PRODUCTS

2.01 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping system and water well has been cleaned, inspected, and pressure tested.

B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.02 DISINFECTION

A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.

B. Provide and attach equipment required to perform the work.

C. Inject treatment disinfectant into piping system.

D. Maintain disinfectant in system for 24 hours.

E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. Test samples in accordance with AWWA C651.

END OF SECTION

SECTION 33 0513
STORM SEWER APPURTENANCES

PART 1 - GENERAL

1.01 GENERAL DESCRIPTION OF WORK:

A. This work shall consist of furnishing and installing appurtenances except manholes, for storm sewers in accordance with details on the plans and as specified herein as directed by the ENGINEER.

B. The various types of structures and appurtenances as inlets, headwalls, energy dissipaters, etc. are designated on the plans by letters or by numbers indicating the particular design of each. Each type shall be constructed in accordance with the details indicated and to the depth required by the profiled and scheduled given.

PART 2 - PRODUCTS

2.01 GENERAL

A. The construction plans will specify the size and material for the pipe between the storm sewer main and the storm water collection structure.

B. The various types of storm inlets and their relation to curb and gutter, or valley gutter are shown on the Standard Detail Drawings. Construction plans will identify the type to be constructed.

C. Grating size, material, and configuration shall conform to the Standard Detail Drawings.

2.02 MATERIALS

A. Concrete
   1. Concrete for cast in place miscellaneous structures shall be Class A concrete when used with precast sewer construction and Class C concrete when used with monolithic pipe sewer construction.
   2. Concrete for precast structures shall be 4000 psi and comply with the applicable requirements of ASTM 478.

B. Mortar:
   1. Mortar shall be composed of 1 part Portland Cement and 2 parts clean, sharp mortar and sand suitably graded for the purpose by conforming in other respects to the provisions of Section 03300 for fine aggregate.
   2. Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight of total dry mix.

C. Reinforcement:
   1. Reinforcing Steel shall conform to Section 03330.

D. Frames, Grates, Rings and Covers:

E. Miscellaneous Items:
   1. Cast iron for supports, steps and inlet units shall conform to the shape and dimensions indicated. The casting shall be clean and perfect, free from sand or blow holes or other defects. Cast iron shall meet the requirements of ASTM A 48, Class 30. Steel for temporary covers when used with Stage Construction shall be adequate for the loads imposed.

PART 3 - EXECUTION

3.01 INSTALLATION OF DRAINAGE FACILITIES:

A. Excavation and backfilling for the storm inlet shall be accompanied in accordance with Section 31 2316.10.

B. Trenching, backfilling, and compaction for the connection pipe between the storm sewer main and the storm inlet shall conform to the specifications contained in Section 31 2316.15.

C. All pipe and structures shall be installed per location and elevation, as shown on the construction plans. If during the course of installation, an underground obstruction (i.e., existing utility line) the work shall stop and the ENGINEER shall be immediately notified so that the problem can be resolved.

D. Removal of curb and gutter, and sidewalk for installation of a storm inlet shall be made at a scored or full depth joint.

E. Existing pavement removal and replacement shall conform to details indicated on the plans.

F. No width greater than ½ inch will be permitted between the inlet grate and the roadside portion of the inlet frame.

G. The construction of inlets shall be done as soon as is practicable after sewer lines into the inlet are complete. All sewers shall be cut nearly at the inside face of the walls of the inlet and pointed up with mortar.

H. The inverts passing out or through an inlet shall be shaped and grout across the floor of the inlet as indicated. This shaping may be accomplished by adding shaping mortar or concrete after the base in cast or by placing the required additional material with the base.

I. All miscellaneous structures shall be completed in accordance with the details indicated. Backfilling to original ground elevation shall be in accordance with the provisions of the appropriate items and as directed by the ENGINEER.

J. PART 4 - MEASUREMENT AND PAYMENT

3.02 MEASUREMENT

A. Pavement removal and replacement will be measured by the square yard.

B. Trenching, backfilling and compaction will not be measured or paid, but will be considered incidental to other items.

C. Frame, grates, rings and covers will not be measured or paid, but will be considered incidental to other items.

D. Connecting pipe shall be measured by the linear foot along centerline of pipe from the main side wall of the inlet to the centerline of the main.

E. Storm sewer inlets shall be measured per each for the type and size specified.

F. All miscellaneous structures satisfactorily completed in accordance with the plan and specifications will be measured as complete units per each.

END OF SECTION

SECTION 33 0514
FIBERGLASS MANHOLES AND WETWELLS

GENERAL

1.01 WORK INCLUDED

A. Furnish all materials, labor and equipment and install fiberglass reinforced polyester manholes and wetwells complete and in place as shown on the Drawings and as specified herein.

1.02 RELATED REQUIREMENTS SPECIFIED ELSEWHERE

A. Excavation and backfill is specified in Section 31 2316.10.

B. Gravel bedding is specified in Plan Sheet Detail.

C. Cast-in-place concrete is specified in Division 3.

D. Manhole frames and covers are specified in Division 3.

1.03 STANDARDS

A. ASTM D-3753: Standard Specification for Glass-Fiber Reinforced Polyester Manholes and Wetwells.

B. ASTM C-581: Practice for Determining Chemical Resistance of Chemical Thermosetting Resins Used in Glass-Fiber Reinforced Structures Intended for Liquid Service.

C. ASTM D-2412: Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.

D. ASTM D-695: Test Methods for Compressive Properties of Rigid Plastics.

E. ASTM D-2584: Test Method for Ignition Loss of Cured Reinforced Resins.

F. ASTM D-790: Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and electrical Insulating Materials.

G. ASTM D-2583: Test Method for Indentation Hardness of Rigid Plastics by means of a Barcol Impressor.

H. AASHTO H-20: Axial Loading.

1.04 QUALITY ASSURANCE

A. Experience Requirements: Manholes and wetwells shall be the product of one (1) manufacturer having at least 5 years successful experience manufacturing fiberglass manholes and wetwells of the types and sizes as specified herein.

B. Inspection:

1. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer, or other representative of the owner. Such inspections shall be made at the place of manufacture, or at site of delivery, and the sections shall be subject to rejection on account of failure to meet any of the specification requirements as specified herein. Sections rejected after delivery to the job site shall be marked for identification and shall be removed from the job at once. All sections which have been damaged after delivery will be rejected, and if already installed shall be acceptable if repaired or removed and replaced at the contractor's expense.
2. At the time of inspection, the material will be examined for compliance with the requirements of this specification and the approved drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.
3. Imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval.

C. Markings: All manholes and wetwells shall be marked on the inside. These markings shall be permanent and include:

1. Manufacturer Identification (Name)
2. Manufacturing Serial Number
3. ASTM Designation
4. Diameter and Length

D. Certification: The manufacturer of the fiberglass wetwells and manholes shall certify that all physical and chemical requirements listed in this specification are met. The certification shall be submitted to the engineer in writing and shall consist of a copy of the manufacturer's test report, accompanied by a copy of the test results, that the manhole has been sampled, tested, and inspected in accordance with the provisions of ASTM 3753 and this specification, and meets all requirements. An authorized agent of the manufacturer shall sign each certification.

E. Acceptable Manufacturers:
1. Containment Solutions, Inc., Conroe, TX.
2. L.F. Manufacturing, Inc., Giddings, TX.
3. Or equivalent.

1.05 SUBMITTALS

A. Manufacturer's descriptive literature and recommended methods of installation.

B. Certificates: Manufacturer's certification in accordance with 1.04.D.

C. Warranties

1.06 GUARANTEE/WARRANTY

A. In addition to the one (1) year warranty provided by the Contractor, wetwells and manholes shall be warranted by the manufacturer for a period of twenty (20) years against internal or internal corrosion and against structural failure.

B. Contractor shall obtain any training from the manufacturer as required for conditions of the warranty to be met.

C. If any wetwell or manhole fails within the warranty period, the manufacturer shall either repair it, deliver a replacement unit to the point of original delivery, or refund the original purchase price.

1.07 DELIVERY, STORAGE AND HANDLING

A. FRP wetwells and manholes shall be lifted by the installation of lifting lugs as specified by the manufacturer on the outside surface near the top of the wetwell. Wetwells and manholes may also be lifted in the horizontal position with two slings on a spreader bar. Use of chains or cables in contact with the wetwell/manhole surface is prohibited.

B. FRP wetwells and manholes may be stored upright or horizontally, however, the wetwell vertical deflection shall not exceed 4% of the diameter. The wetwell shall not be dropped or impacted.

C. Additional handling and installation instructions shall be in accordance with the FRP manufacturer's instructions.

D. Each FRP section manufactured in accordance with the drawings shall be clearly marked to indicate the intended installation location. The contractor shall be responsible for the installation of the correct FRP sections in their designated locations.

1.08 PRODUCTS

1.09 GENERAL REQUIREMENTS

A. Fiberglass reinforced polyester wetwells and manholes shall be manufactured from commercial grade polyester resin having fiberglass reinforcements. The resin system shall be suitable for atmospheres containing hydrogen sulfide and dilute sulfuric acid as well as other gases associated with the wastewater collection systems. Wetwells and manholes shall be a one-piece unit.

1.10 MATERIALS

A. Resin: The resins used shall be a commercial grade unsaturated polyester resin. UV inhibitors shall be added directly to resins to prevent photo-degradation during storage.

B. 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.

C. Surfacing Materials: If reinforcing material is used on the surface exposed to wastewater and sewer gases, it shall be a commercial grade chemical-resistant glass that will provide a suitable bond with the resin and leave a resin rich surface.

D. 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.

1.11 FABRICATION

A. Exterior Surface: The exterior surface shall be relatively smooth with no sharp projections. Handwork finish is acceptable if enough resin is present to eliminate fiber show. The exterior surface shall be free of blisters larger than 1/2 inch in diameter, delamination and fiber show.

B. Interior Surface: The interior surface shall be resin rich with no exposed fibers. The surface shall be free of grazing, delamination, and blisters larger than 1/2 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 3/4 inch in diameter and less than 1/16 inch deep.

C. Cylinder Section: Cylinders shall meet all requirements for pipe stiffness as required in ASTM D3753. All wetwells and manholes 6-foot diameter and larger shall be rib reinforced.

D. Fiberglass Reinforced Top/Cone: The fiberglass wetwell top or manhole cone shall be fabricated using fiberglass material as specified in Paragraph 2.02 and shall meet all requirements in 2.04 of this Section. Tops and cones to be attached to the cylinder at the factory with fiberglass layup in compliance with ASTM-D3299.

1. Wetwell Tops and Hatch Openings:
    a. Wetwells shall be provided with glass reinforced tops as shown on the Drawings and shall be joined to the cylinder section at the factory with resin and glass fiber reinforcement forming a monolithic structure to prevent infiltration and exfiltration.
    b. Wetwell top shall be designed to withstand backfill and concrete slab. When reinforcement is necessary for strength, the reinforcement shall be fiberglass channel laminated to top per ASTM-D3299. Stiffeners shall be of non-corrosive materials encapsulated in fiberglass. FRP encapsulated wood or lumber is not permitted.
    c. Hatch opening dimensions and position to be as shown on the drawings and specified in Section 11322.
    d. Vapor barrier lip around hatch opening shall be constructed of fiberglass pultruded structural shapes. Vapor barrier lip shall extend to the hatch frame as shown on the Drawings so that no concrete of the top slab is exposed to the wetwell interior. Contractor to coordinate this dimensional requirement.
2. Manhole Cones:
    a. The manway cone on manholes must provide a bearing surface on which a standard frame and cover may be supported and adjusted to grade.
    b. The cone shall be concentric and shall be joined to the cylinder section at the factory with resin and glass fiber reinforcement forming a monolithic structure to prevent infiltration and exfiltration.
    c. Manway cone shall have a raised collar around the manway opening over which HDPE manhole adjustment rings may be installed.

E. Bottom Flange: All wetwells shall have an integral bottom flange of minimum 3-inch width as shown on the drawings for embedment and anchoring of the cylinder in the concrete base slab. Where indicated on the drawings, manholes shall also have bottom flange.

F. Stubouts and Connections:
   1. Pipe connections 4" through 15" in diameter shall be made by means of "Inserta Tee" watertight compression connection. Connections may be factory installed.
   2. Pipe connections larger than 15" in diameter shall be factory installed and be of the following types:
      a. Rubber gasketed PVC sewer pipe stubouts installed with resin and glass fiber reinforced lay-up. Gaskets shall meet the same performance requirements of the sewer pipe to be installed.
      b. PVC or FRP pipe stubouts with resilient pipe-to-wetwell connectors (boots) conforming to the requirements of ASTM C-923.

G. Defects not Permitted:
   1. Exposed fibers: glass fibers not wet out with resin.
   2. Resin runs: runs of resin and sand on the surface.
   3. Dry areas: areas with glass not wet out with resin.
   4. Delamination: separation in the laminate.
   5. Blisters: light colored areas larger than 1/2 inch in diameter.
   6. Crazing: cracks caused by sharp objects.
   7. Pits or Voids: air pockets.
   8. Wrinkles: smooth irregularities in the surface.
   9. Sharp projection: fiber or resin projections necessitating gloves for handling.

1.12 DESIGN REQUIREMENTS

A. Wetwells and manholes shall be designed by the manufacturer to perform as underground structures at the depths required.

B. Complete manhole FRP structures shall be capable of supporting the top slab covers, frames, and soil overburdens plus a live load equivalent to AASHTO HS-20 loading. To establish this rating, the complete manhole shall not leak, crack, or suffer other damage when load tested to 40,000 ft-lbs and shall not deflect vertically downward more than 1/4 inch at the point of load application when loaded to 24,000 lbs.

C. Cylinders shall be resistant to buckling when empty and when the groundwater elevation is at grade.

D. The anchoring wall structure at the embankment within the reinforced concrete base zone shall be designed to resist external hydrostatic water forces of an empty or full cylinder with the groundwater at grade elevation.

E. All cutouts for pipe connections specified and shown on the Drawings shall be capable of maintaining the unit's structural integrity.

F. Stiffness: The cylinder shall be tested in accordance with ASTM Method D 2412. The wetwell cylinder shall have the minimum pipe-stiffness values shown in the following table when tested in accordance with ASTM 3753, Section 8.5, (note 1).
   1. STIFFNESS REQUIREMENTS
   2. Length (ft) F/AY (psi)
   3. 3 to 6 0.72
   4. 7 to 12 1.26
   5. 10 to 20 2.01
   6. 21 to 30 3.02
   7. 31 to 40 5.24

G. Physical Properties: Hoop Direction Axial Direction
   1. Tensile Strength (psi) 18,000 5,000

3.	Tensile Modulus (psi)	0.8 x 106	0.7 x 106
4.	Flexural Strength (psi)	22,500	14,300
5.	Flexural Modulus (psi)		
	a. (no ribs - 48", 60", 72")	1.4 x 106	0.7 x 106
	b. (with ribs - 72", 96", 144")	0.7 x 106	0.7 x 106

H. Dimensional Requirements:
1. The wetwells and manholes shall be a circular cylinder, sized per the plans for the applicable locations. Wetwells shall be produced per the length indicated on the plans +/- ½". Manholes shall be produced in half-foot increments of length +/- 2 inches. Tolerance on the inside diameter shall be +/- 1%. Other diameters as agreed upon between purchaser and the manufacturer are covered by this specification.
2. The minimum wall thickness for all wetwells and manholes at any depth shall be 0.50 inches measured to the nearest percent (0.01 inches) with micrometer, caliper, gauge or other suitable instrument. A minimum of one thickness reading per 33.4 ft2 of laminated surface in area of constant thickness shall be made. Through regions of wall taper, sufficient checks must be made to establish actual thickness. The test shall be run at least once per ten manholes.

1.13 EXECUTION

1.14 EXCAVATION

A. The Contractor shall do all necessary excavation for the various wetwells and manholes. Such excavations shall be of sufficient size to permit the proper installation of the base and wall forms and allow room for the striping of forms. All excavation shall conform to the size and dimensions as shown on the drawings plus a maximum of four feet to permit working room.

B. Care shall be taken to insure that the excavation is not carried to a greater depth than required. If shoring the wall of the excavated area becomes necessary, shoring shall be of two-inch material. Shoring shall be braced to insure support of the walls and also permit the construction of the wetwell or manhole itself without necessitating the removal of any shoring until such time as the entire manhole is completed. No shoring shall be left or backfilled around, unless authorized by the engineer. Shoring shall remain in place for at least twenty-four hours after the concrete work has been completed.

C. Contractor shall be responsible for handling groundwater to provide firm, dry subgrade for the structure, shall prevent water from rising on new poured-in-place concrete within 24 hours after placing, and shall guard against flotation or other damages resulting from groundwater or flooding. The Contractor shall be fully responsible and liable for all damages resulting from failure of the dewatering plan or system. Refer to Section 01563 GROUNDWATER HANDLING.

1.15 GENERAL CONSTRUCTION METHODS

A. All wetwell and manhole work shall be completed and finished in a careful and workmanlike manner, special care being given to cutting and installing wall penetrations in the wall of the cylinder.

B. Field-installed connections for sewer pipe 4" through 15" in diameter shall be made by means of watertight compression connection (e.g. "Inserta Tee", or approved equal) as shown on the plans and details. Cutouts and installation shall be in strict accordance with manufacturer's written instructions utilizing installation equipment (e.g. hole saw) approved for use by the manufacturer of the fitting. Use of equipment which does not meet this requirement is expressly prohibited. Jig saws, saber saws, or axes, hammers, chisels, and similar impact type tools shall not be used.

C. Field fabrication of stubouts using FRP lay-up reinforcement is prohibited unless approved in writing by the Engineer.

D. All connections shall be made on flat surfaces of cylinder or top away from structural ribs. Contractor shall coordinate location and elevations of all connections with the manufacturer before fabrication to ensure this requirement is met.

E. All cut edges where glass fiber is exposed (e.g. hole saw cuts in the cylinder section or top) shall be coated with resin to prevent wicking of moisture into fiberglass laminate. Contractor shall use resin of the same type and grade as used in the fabrication of the wetwell/manhole.

F. The bottom of manholes shall be completed by installing sufficient additional concrete/grout to shape or form the bench as shown on the drawings.

G. The cast-in-place concrete base slab shall be placed on a 6-inch minimum bed of gravel. Sub-base soil below gravel bed shall be thoroughly compacted to minimum 95% Standard Proctor Density.

H. The bottom of the fiberglass manhole or wetwell shall be cast-in-place a minimum of 4 inches and shall be adjusted in grade so that the top slab section is at the elevation specified in the drawings. Contractor shall be responsible for coordinating and verifying all dimensional requirements as specified and shown on the Drawings.

I. Contractor shall internally brace fiberglass wetwell tops during placement of top slab concrete to support and prevent deflection of the top while the slab cures.

1.16 BACKFILLING

A. Anti-flotation rings made from lean concrete mix shall be poured in place around manhole and wetwell in quantities as shown on the Drawings. Anti-flotation rings shall be poured only after the concrete base slab has been allowed to cure the required time and the forms and shoring have been removed.

B. The backfilling around the outside of manholes shall commence as soon as the anti-flotation ring has cured. Backfill shall be placed in layers of not more than 12 inches and shall be thoroughly tamped before the next layer is installed.

C. Backfill shall be either hand or mechanically tamped. Whichever method is used, care must be exercised to insure that the backfill is thoroughly compacted to 90% Standard Proctor Density (ASTM D-690).

D. Unless shown otherwise on the drawings, suitable material selected from the excavation shall be used for backfill. Material shall be subject to approval by the Engineer.

1.17 DROP MANHOLES

A. Drop manholes shall consist of a standard sanitary sewer manhole with one standard drop connection on one side only, as shown in the detail drawings. All materials used in the drop connection shall conform to the requirements of the pertinent specification.

1.18 CASTINGS AND CLEANING

A. Manhole frames and covers within the limits of bituminous concrete pavement shall be set at the elevation of the top of the wearing course.

B. All new manholes and wetwells shall be thoroughly cleaned by the removal of all accumulations of silt, debris and foreign matter of any kind, prior to final inspection.

1.19 MANHOLE TESTING

A. Refer to Section 02570 for manhole testing requirements.

1.20 WETWELL TESTING

A. Successful passage of a hydrostatic test shall be required for acceptance of all wetwells. Testing shall be conducted with all connections in place. If a wetwell fails a hydrostatic leakage test, it shall be made watertight and retested.

B. Test Procedure:
   1. Pneumatic test plugs with a sealing length equal to or greater than the diameter of the connecting pipe to be sealed shall be used to plug all influent, effluent, and vent pipes.

2. Wetwell shall be filled with water (provided by the Contractor and as approved by the Engineer) to a pre-determined level at or immediately below the underside of the fiberglass top. Additional water may be added over a twenty-four (24) hour period to compensate for absorption and evaporation losses.
3. At the conclusion of the twenty-four (24) hour saturation period, the wetwell shall be filled to the original level and the water level observed by reference to gradations marked on a measuring rod or a pump guide rail.
4. The wetwell shall be considered to pass the hydrostatic test if the rate of leakage or water loss is equal to or less than 0.025 gallons per foot diameter per foot of wetwell depth per hour.

C. Testing and Certification:
1. Testing shall be done by the Contractor and witnessed by the Engineer or his representative. All wetwells shall be tested as finished and completed for final acceptance.
2. Any defective work or materials shall be corrected or replaced by the contractor and retested. This shall be repeated until all work and materials are acceptable.

END OF SECTION

SECTION 33 1116
WATER TRANSMISSION LINES AND/OR PRESSURE SEWER LINES

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS SPECIFIED ELSEWHERE:

A. Trenching, Backfilling and Compacting: Section 31 2316.13.

B. SUBMITTALS:

C. Manufacturer's Literature: Manufacturer's descriptive literature and recommended method of installation.

D. Certificates: Manufacturer's certification that products meet specification requirements.

E. PRODUCT DELIVERY, STORAGE, AND HANDLING:

F. Deliver materials on manufacturer's original skids or in original unopened protective packaging. OWNER reserves the right to reject material left from another job.

G. Store materials to prevent physical damage.

H. Protect materials during transportation and installation to avoid physical damage.

I. GENERAL DESCRIPTION OF WORK COVERED:

J. Furnish and install all pipe, fittings, structures and accessories required for water transmission line and/or pressure sewer lines.

K. QUALITY ASSURANCE:

L. Comply with the latest published edition of American Water Works Association (AWWA) Standards:
   1. AWWA C110 & C11Oa - Gray Iron and Ductile-Iron Fittings, 2 inch through 48 inch for water and other liquids.
   2. AWWA Clll - Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings.
   3. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
   4. AWWA C151 - Ductile-Iron Pipe, centrifugally cast in metal mold or sand lined molds, for water or other liquids.
   5. AWWA C153 - Ductile-Iron Compact fittings, 3 inch through 12 inch for water and other liquids.
   6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe 4 inch through 12 inch for water.
   7. AWWA C301-79 - Prestressed Concrete Pressure Pipe - Steel Cylinder Type, for water and other liquids.

M. Comply with the latest published editions of the American Society for Testing and Materials (ASTM) Standards:
   1. D 2241 - Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR).
   2. D 3139 - Joints for PVC Pressure Pipes using Flexible Elastomeric Seals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. Pipe furnished may be either PVC or steel cylinder as specified herein for water mains unless shown otherwise on the plans or bid documents.

B. Use PVC pipe for all pressure sewer lines unless shown otherwise on the plans.

C. All pipe shall be marked in accordance with the applicable standard specification under which the pipe is manufactured unless otherwise specified.

D. Steel cylinder pipe manufactured shall have had a successful experience record in the design and manufacture of steel cylinder pipe with substantial footage in successful operation for at least five years.

E. POLYVINYL CHLORIDE PIPE (PVC):

F. Provide pipe meeting AWWA C900 PVC 1120 or ASTM D2241 Type 1 Grade 1 PVC 1120 Standards.
   1. Minimum requirements:
      a. Pressure Pressure

2. Size	DR	Class(psi)	Rating(psi)
3. 4"-12"	18	150	150
4. 2"- 4"	26	95	160
5. 6"-12"	21	120	200

   6. Use pipe meeting minimum requirements unless shown otherwise on plans.

G. Provide push-on joints with bell integrally cast into pipe or with coupling of same material as pipe.

H. Use elastomeric gaskets, as provided in AWWA C900 or ASTM D3139.

I. Provide either cast-iron or PVC 1120 fittings as indicated or required. Use long radius fittings where possible.

J. Provide fittings with materials and pressure class equal to or greater than that specified for pipe.

K. Provide sleeve type or anchored coupling where indicated or required to join pipe or provide restraint to offset internal or hydrostatic test pressures.

L. Provide pipe marked to indicate the following:
   1. Nominal Pipe Size.
   2. Material Code Designation.
   3. Standard Dimension Ratio.
   4. Pressure Rating.
   5. Manufacturer's name or trademark.
   6. National Sanitation Foundation Seal.
   7. Appropriate ASTM designation number.
   8. STEEL CYLINDER PIPE (SCP):

M. Provide pipe meeting AWWA C301-79.

N. All pipe and fittings shall have the approval of the Underwriter's Laboratories, Inc.

O. Provide pipe with minimum pressure class of 150 psi or as shown on plans or in Special Conditions.

P. Provide fittings with materials and pressure class equal to or greater than that specified for pipe.

Q. Joint wrappers:
   1. Shall be of quality manufactured by Mar-Mac-Manufacturing Company or approved equal.
   2. Shall be hemmed at each edge to allow threading with a steel strap to securely fasten the wrapper around the pipe by means of a stretcher and sealer.
   3. Minimum width of 7 inches for pipe with diameter of 33 inches or smaller; 9 inches for pipe with diameter greater than 33 inches.
   4. Length sufficient to circle pipe.

R. Cement Mortar:
   1. Mortar used at joint shall consist of 1 part portland cement to 2 1/2 parts fine, sharp clean sand mixed with water.
   2. Interior joint mortar shall be mixed with as little water as possible to produce a very stiff but workable mixture.
   3. Exterior joint mortar shall be mixed with water to a consistency of thick cream.

S. Provide pipe marked to indicate the following:
   1. Pressure for which the pipe or fitting is designed.
   2. Identification marks to show proper location.

3. All beveled pipe shall be marked with the amount of the bevel.
4. Manufacturer's name.
5. Material code designation.
6. National Sanitation Foundation Seal.
7. DUCTILE IRON PIPE FITTINGS (DIP):

T. Shall be in accordance with AWWA C-llO with pressure rating of not less than that specified for adjacent pipe.

U. Shall be compatible with joint type of adjacent pipe.

V. All specials, taps, plugs, flanges and wall fittings shall be as required.

W. Shall have cement mortar lining in accordance with AWWA C104.

X. Shall be coated with manufacturer's standard coating.

Y. VALVES, HYDRANTS AND METERS:

Z. Gate Valves:
1. Design: AWWA C-509, CRS-80 by American Darling, Metroseal by U.S. Pipe, Mueller, or equal.
2. Type: Compression Resilient Seated.
3. Material: Cast iron body with epoxy coated interior.
4. Rating: 200 psi working pressure class.
5. Stem: Double "O" ring stem seal.
6. Operators: Open counterclockwise with 2 inch square operating nut.
7. Flange: x push-on valves must be used on all fire hydrants installed on water main 10 inches or larger.

AA. Valve Boxes:
1. Provide for all buried valves.
2. Use nominal 6 inch cast-iron sliding type pipe shaft with cover and base casting.
3. Set box top at finished grade.
4. Furnish drop cover appropriately marked "WATER".

AB. Corporation Stops:
1. Conform with AWWA C-800.
2. Use 3/4 inch unless indicated otherwise.

AC. Hydrants:
1. Design: latest edition of AWWA C502, traffic model with break flange.
2. Mueller Centrurion - A423
   a. American-Darling - B-84-B
   b. Kennedy Guardian - K-81A
   c. U.S. Pipe - Metropolitan
   d. Others as approved by OWNER in writing
3. Provide 6 inch inlet, 2 - 2> inch hose nozzles, 1 - 4> inch pumper.
4. Provide compression type main valve, minimum size 5< inches.
5. Pentagon operating nut.
6. Design to open counterclockwise.
7. Provide mechanical joint bell on footpiece.
8. Furnish depth as noted on plans.
9. Furnish National (American) Standard Fire Hose Coupling Screw Thread (NH).

AD. Polyethylene Wrapping:
1. Material: AWWA C105.
2. Thickness: 8 mils.

AE. Polyethylene Plastic Pipe (PE):
1. Material: ASTM D2737.

2. Fittings: ASTM D2683.
3. Size: 3/4 inch unless shown otherwise on plans.

AF. Copper Pipe (CU):
1. Material: seamless, Type K, ATM B88.
2. Fittings: wrought copper solder joint or flared.
3. Size: 3/4 inch unless shown otherwise on plans.

PART 3 - EXECUTION

3.01 GENERAL:

A. Provide all labor, equipment and materials and install all pipe fittings, special and appurtenances as indicated or specified.

B. PIPE INSTALLATION:

C. Handling:
1. Handle in a manner to insure installation in sound and undamaged condition.
a. Do not drop or bump.
b. Use slings, lifting lugs, hooks and other devices designed to protect pipe, joint elements, and coatings.
2. Ship, move and store with provisions to prevent movement or shock contact with adjacent units.
3. Handle with equipment capable of work with adequate factor of safety against overturning or other unsafe procedures.

D. Installation:
1. Utilize equipment, methods, and materials insuring installation to lines and grades as indicated.
a. Do not lay on blocks unless pipe is to receive total concrete encasement.

E. Accomplish horizontal and vertical curve alignments of ductile iron pipe with bends, bevels or deflection joints.
1. Limit joint deflection with ductile iron pipe to conform with AWWA C600.
2. Use short specials preceding curves as required.
3. Obtain approval of ENGINEER of method proposed or transfer of line and grade from control to the work.
4. Install pipe of size, material, strength class, and joint type with embedment as shown on plans or specified herein.
5. Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during discontinuance of installation.
a. Close open ends of pipe with snug fitting closures.
b. Do not let water fill trench. Include provisions to pre-vent flotation should water control measures prove inadequate.
c. Remove water, sand, mud and usher undesirable materials from trench before removal of end cap.
6. Pipe shall be inspected prior to installation to determine if any pipe defects are present.
7. Brace or anchor as required to prevent displacement after establishing final position.
8. Perform only when weather and trench conditions are suitable.
a. Do not lay in water.
9. Observe extra precaution when hazardous atmospheres might be encountered.
10. Sanitary sewer relation to water mains:
a. Maintain 9 feet horizontal separation whenever possible.
b. When conditions prevent a lateral separation of 9 feet, sewer may be installed closer to a water main if:
1) sewer constructed of PVC pipe meeting AWWA Specifications and having a minimum working pressure rating of 150 psi or greater and equipped with pressure type joints, and

2) the sewer line and water main are separated by a minimum vertical distance of 2 feet and a minimum horizontal distance of 4 feet, measured between the nearest outside diameters of the pipes.

c. When a sanitary sewer crosses a water line and that portion of the sewer is constructed as described is 3.02 B.9.b.(1), the sewer may be placed no closer than 6 inches from the water line. The separation distance must be measured between the nearest outside pipe diameters. The sewer line shall be located at a lower elevation than the water line whenever possible and one length of the sewer pipe must be centered on the water line.

11. Separation of water mains from sewer manholes:
    a. No water pipe shall pass through or come in contract with any part of a sewer manhole.
    b. A minimum horizontal separation of 9 feet shall be maintained.
12. Construct service lines where shown on plans in accordance with Standard Detail Drawing D-48 or D-49. Use pipe material specified on plans or in contract documents.
13. Wrap pipe, fittings and tie rods with polyethylene where shown on plans in accordance with AWWA C105.

F. Jointing:
1. General requirements:
    a. Locate joint to provide for differential movement at changes in type of pipe embedment, at changes from rock to soil trench bottom, and structures.
        1) Not more than 18 inches from structure wall, or
        2) Support pipe from wall to first joint with concrete cradle structurally continuous with base slab or footing of structure.
        3) Perform in accordance with manufacturer's recommendations.
        4) Clean and lubricate all joint and gasket surfaces with lubricant recommended.
        5) Utilize methods and equipment capable of fully homing or making up joints without damage.
        6) Check joint opening and deflection for specification limits.
2. Special provisions for jointing cast-iron and ductile iron:
    a. Conform to AWWA C600.
    b. Visually examine while suspended and before lowering into trench.
        1) Paint bell, spigot, or other suspected portions with turpentine and dust with cement to check for cracks invisible to the eye.
        2) Remove turpentine and cement by washing when test is satisfactorily completed.
        3) Reject all defective pipe.
3. Special provisions for jointing and laying PVC pipe:
    a. Conform to AWWA C600 and ASTM D2321.
    b. Allow pipe to reach trench soil temperature prior to installation in ditch.
4. Special provisions for jointing steel cylinder pipe:
    a. Before laying each joint, the bell and spigot rings shall be cleaned by wire brush and wiped clean and dry.
    b. Inside cement mortar joint:
        1) the inside joint recess shall be filled immediately prior to placing the pipe together by buttering the bell end with mortar.
        2) the joint mortar of pipe 18 inch diameter and smaller shall be smoothed and cleaned with a swab.
        3) the joint mortar of pipe diameters larger than 18 inches shall be finished off smooth by hand trowel.
        4) Outside cement mortar joint:
            (a) encircle joint with wrapper after joint found satisfactory.

(b) leave enough space between wrapper ends to allow cement mortar to be poured.
(c) the entire joint shall be poured with cement mortar and consolidated and rodded or agitated to eliminate voids.

G. Cutting:
1. Cut in neat workmanlike manner without damage to pipe.
2. Cut cast-iron with carborundum saw or other approved method.
a. Smooth cut by power grinding to remove burrs and sharp edges.
b. Repair lining as required and approved by ENGINEER.

H. Closure Pieces:
1. Connect two segments of pipelines or a pipeline segment and existing structure with short sections of pipe fabricated for the purpose.
2. Observe specifications regarding location of joints, type of joints and pipe materials and strength classifications.
3. May be accomplished with sleeve coupling for water pipe:
a. Of length such that gaskets are not less than 3 inches from pipe ends.
b. Include spacer ring identical to pipe end such that clear space does not exceed 1/4 inch.

I. Temporary Plugs:
1. Install whenever installed pipe is left unattended.
2. Use water tight plug.

J. Thrust Blocks:
1. Provide for all horizontal or vertical turns utilizing fittings.
2. Use on all dead-end and tee fittings.
3. Install as indicated on Standard Detail Drawing D-7
4. Construct to undisturbed edge of trench for bearing.
5. Provide minimum bearing area in S.F. as follows based on 150 psi test pressure and 2000 psf soil bearing:

Pipe Size	Plug, T's	11-1/4º Bend	22-1/2º Bend	45º Bend	90º Bend
4"	1.0	.5	.5	.8	1.3
6"	2.2	.5	.9	1.6	3.0
8"	3.8	.8	1.5	2.9	5.3
10"	6.0	1.12	2.3	4.5	8.4
12"	8.5	1.7	3.3	6.5	12.1
14"	11.6	2.3	4.5	8.9	16.4
16"	15.2	3.0	5.9	11.6	21.4
other	Submit Calculations	Submit Calculation	Submit Calculations	Submit Calculations	Submit Calculations

K. VALVE AND APPURTENANCE INSTALLATION:
1. Valves:
a. Install with stems vertical when installation is horizontal.
b. Set valves on concrete thrust block having four (4) square feet of bearing area on undisturbed earth.

L. Valve Boxes:
1. Center on valves.
2. Carefully tamp earth around each valve box to a distance of 4 feet on all sides of box or to undisturbed trench face, if less than 4 feet.

M. Hydrants:
1. Set hydrants where shown on plans in accordance with Standard Detail Drawing D-12.

2. Install gravel, blocks and anchors in accordance with Standard Detail Drawing D-12.
3. Set reference elevation 3 inches above existing grade or to elevation established by ENGINEER (not to exceed 6 inches).
4. Break-a-way flange to be either ground level where applicable or between 3 inches and 6 inches above curb as established by ENGINEER.

5. ACCEPTANCE TESTS FOR PRESSURE MAINS:

N. Perform hydrostatic pressure and leakage test.
   1. Conform to AWWA C600 procedures.
      a. As modified herein.
      b. Shall apply to all pipe materials specified.
      c. Perform after backfilling.

O. Test separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs.
   1. CONTRACTOR to furnish and install test plugs, including all anchors, braces and other temporary or permanent devices to withstand hydrostatic pressure on plugs, at no additional cost to the OWNER.
   2. CONTRACTOR responsible for any damage to public or private property caused by failure of plugs.

P. Limit fill rate of line to available venting capacity. Fill rate shall be regulated to limit velocity in lines when flowing full to not more than 1 fps.

Q. OWNER will make water for testing available to contractor at nearest source. Valves of existing system will at all times be operated by City personnel only.

R. Pressure test:
   1. Conduct at pressure at least 1.5 times than normal working pressure (not less than 150 psi test pressure).
   2. Maintain pressure for a minimum of two (2) hours.
   3. Test pressure shall not vary by more than +5 psil'6 (-- 9C.1Y)

S. Leakage Test:
   1. Conduct concurrently with the pressure test.
   2. Maintain pressure for a minimum of two (2) hours.
   3. Acceptable when leakage does not exceed that determined by the following formula:
      a. L = ND P
      b. 7400
         1) L = Maximum permissible leakage in gallons per hour.
         2) N = Number of pipe joints in segment under test.
         3) D = Nominal internal diameter of pipe being tested in inches.
         4) P = Average actual leakage test pressure, psig.
   4. Repeat leakage test as necessary.
      a. After location of leaks and repair or replacement of defective joints, pipe or fittings.
      b. Until satisfactory performance of test. c. At no increase in cost to the OWNER.

T. Refit and replace all pipe not meeting the leakage or pressure requirements. Repair clamp is not permitted.

U. Repair all visible leaks regardless of the amount of leakage.

V. OWNER or ENGINEER will observe all tests.

W. DISINFECTION OF PIPELINES FOR CONVEYING POTABLE WATER:

X. CONTRACTOR provide all equipment and materials and perform in accordance with AWWA C601.
   1. As modified herein.
   2. Include chlorination and final flushing.

Y. Add chlorine to attain an initial concentration of 50 mg/l chlorine with 10 mg/l remaining after 24 hours.

Z. Flush main until concentration is 2 mg/l or less prior to placing main in service.

AA. Obtain approval of materials and methods proposed for use.

AB. May be conducted in conjunction with acceptance tests.

AC. Dispose of flushing water without damage to public or private property.

AD. Repeat disinfection procedure should initial treatment fail to yield satisfactory results.
1. At no additional cost to the OWNER.
2. OWNER will provide water under terms specified for acceptance tests.

AE. Do not exceed 500 gpm rate in flushing.

AF. Provide safe bacterial sample results before placing main into service.

AG. PART 4 - MEASUREMENT AND PAYMENT

AH. PRESSURE LINES:

AI. Line shall be measured along the center of the pipe without considering fittings or other pipe connections. The line will be paid at the contract bid price per linear feet.

AJ. Compensation will be for furnishing all materials, labor, equipment, tools and incidental work required by the construction of the pressure line, all in accordance with the plans and these specifications.

AK. If pressure line fails any test procedure, trouble spot is to be corrected all as incidental to the construction of the pressure line.

END OF SECTION

SECTION 33 3113
SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

C. Cleanout access.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

B. Section 31 2316 - Excavation: Excavating of trenches.

C. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 31 2323 - Fill: Bedding and backfilling.

E. Section 33 0513 - Manholes and Structures.

1.03 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 REFERENCE STANDARDS

A. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2014.

B. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings; 2005.

C. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2015.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories, and _____.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Project Record Documents:
   1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Provide products that comply with applicable code(s).

B. Plastic Pipe: ASTM D2241 SDR 21, Class 200 (PVC) material; inside nominal diameter of 6 inches, bell and spigot style solvent sealed joint end.

C. 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.

2.02 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

2.03 CLEANOUT MANHOLE

A. Lid and Frame: Cast iron construction, hinged lid.

1. Nominal Lid and Frame Size: 26 inches.

2.04 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: As specified in Plan Detail Sheet.

B. Pipe Cover Material: As specified in Plan Detail Sheet.

PART 3 EXECUTION

3.01 GENERAL

A. Perform work in accordance with applicable code(s).

3.02 TRENCHING

A. See Section 31 2316.13 for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
   1. Plastic Pipe: Also comply with ASTM D2321.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

D. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.

E. Install trace wire 6 inches above top of pipe; coordinate with Section 31 2316.13.

3.04 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 end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.05 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 4211
STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Storm drainage piping, fittings, and accessories.

B. Connection of drainage system to municipal sewers.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

B. Section 31 2316 - Excavation: Excavating of trenches.

C. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 31 2323 - Fill: Bedding and backfilling.

E. Section 33 0513 - Manholes and Structures.

1.03 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

B. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2015.

C. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2012.

D. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2015.

E. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2011.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories,and _____.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Project Record Documents:
   1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for materials and installation of the Work of this section.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Provide products that comply with applicable code(s).

B. Concrete Pipe Joint Devices: ASTM C443 (ASTM C443M) rubber compression gasket joint.

C. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class IIII and Class IV .A; meshreinforcement; inside nominal diameter of see plan inches, bell and spigot end joints.

D. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.

2.02 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS

A. As shown on the plans

END OF SECTION

SECTION 33 71 19 – UNDERGROUND DUCT BANKS AND MANHOLES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to provide underground ductbanks in reinforced concrete.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for underground electrical ductbanks. All earth and concrete work under this Section shall be under the supervision of the Civil Engineer.

1. Division 01 Sections included in the project specifications
2. Excavation Support Systems
3. Excavation and Backfilling
4. Concrete Formwork
5. Concrete Reinforcement and Embedded Materials
6. Section 26 00 00 - Basic Electrical Requirements
7. Section 26 05 00 - Basic Electrical Materials and Methods
8. Section 26 05 33 - Raceway, Conduit, and Boxes

B. In the event of conflict involving underground electrical ductbank requirements between this Section and any other Sections, the provisions of this Section shall govern.

1.3 APPLICABLE CODES AND STANDARDS

A. NEMA TC 6 & 8 – Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations

B. NEMA TC 9 – Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations

C. ASTM C 31 – Standards Practice for Making and Curing Concrete Test Specimens in the Field

D. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

E. ASTM C 172 – Standards Practice for Sampling Freshly Mixed Concrete

F. ACI 301 – Structural Concrete

G. ASTM A 615 – Deformed and Plain Carbon Steel Bars for Concrete Reinforcement

H. ASTM D 698 – Standard Test Methods for laboratory Compaction Characteristics of Soil Using Standard Effort

1.4 SUBMITTALS

A. Submit the following in addition to, and in accordance with, Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

1. Complete list of equipment and materials including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions for conduit and fittings, concrete (including admixture), and rebar.
2. Ready-mix delivery tickets shall be submitted to the Owner for review prior to unloading at the site.
3. Delivery ticket minimum information:
    a. Name of ready-mix plant
    b. Serial number of ticket
    c. Date and truck number
    d. Name of contractor
    e. Job name and location
    f. Mix design number
    g. Amount concrete (cubic yards)
    h. Type and amount of admixtures
    i. Amount of water added at the batch plant
    j. Times of loading, arriving at the site, and unloading
    k. Volume of water added by receiver of concrete and his initials
4. Provide concrete testing and inspection as required by Division 03 specifications.
5. Submit trench safety plans, sealed and signed by a professional engineer registered in the State of Texas, as outlined by 3.1 A of this specification.

B. Provide the following one week before pulling medium-voltage cable:

1. Diagram of ductbank indicating lengths of straight conduit sections, bend locations with radius of bands, conduit sizes.
2. Pulling calculation per cable manufacturer's recommended method with acceptable values for pulling tension and sidewall pressure indicated for each cable size/type.

1.5 WARRANTY

A. Provide a warranty for material and installation per Section 26 00 00, Basic Electrical Requirements, unless a longer warranty period is required in specific product specifications.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. All products shall be new, first-quality materials.

B. Nonmetallic Conduit: rigid PVC per NEMA TC-6 & 8. Conduit sizes and type shall be in accordance with Drawings. Conduit shall be of standard length, with tapered end and matching solvent weld couplings. Provide fitting of the same type material as ducts.

C. Provide spacers with minimum separation between conduits as indicated on Drawings.

D. Provide full length polypropylene pull rope in empty conduits installed.

E. Provide schedule 40 PVC for all conduits located below grade, both in and out of ductbanks, unless otherwise noted on drawings.

F. Provide 10 foot section of galvanized rigid steel conduit where transitioning from ductbank outside building footprint to cement stabilized sand under the footprint of the building with the 10 foot section centered on the edge of the building footprint.

2.2 CONCRETE

A. Cast-in-place concrete and components: Conform to the following general requirements:

1. Provide concrete work per ACI 301.

2. Concrete shall be normal weight, air-entrained with 28 day strength of 2,500 psi or per the direction of the Civil Engineer.

3. Slump: Performed at the point of placement shall not exceed 6 inches. Make slump tests for each nine cubic yards of concrete placed.

4. Color: All electrical ductbank concrete shall be color dyed by mixing red inorganic pigment (iron oxide) in cement; rate shall be 1 ½ pounds of iron oxide per cubic yard of cement. All communications duct bank shall be dyed orange in a manner acceptable to the Owner. The inner duct for telecom shall be UL listed for underground use with optical and copper communication cables.

5. Cylinder Tests: Make four cylinder tests from each pouring operation and not less than four cylinders for each 18 cubic yards, or part thereof, over 10 cubic yards of concrete poured and not less than once a day nor less than once for each concreting operation. Take samples at point of placement; conform to ASTM C 172 and ASTM C 31.

   a. Test two (2) cylinders at 7 days.

   b. Test two (2) cylinders at 28 days.

   c. Tests conform to ASTM C 39.

6. Temperature limits for concrete work shall be in accordance with civil engineering standard.

2.3 REINFORCING STEEL

A. All ductbanks shall be constructed with reinforcing bars in the ductbank. The quantities and sizes of the reinforcing bars shall be provided as directed by the project structural engineer.

2.4 MANHOLES

A. The manholes shall be precast concrete quality and dimensions as per civil drawings. The manhole shall have grade 60 reinforcement of H20 loading and 4,500 psi concrete. Precast end bell type terminators shall be provided for each ductbank entry as noted on the Drawings. Pulling eyes shall be located opposite each set of duct openings. The manhole shall include a 30 inch type B frame and cover suitable for vehicular traffic appropriately marked “electric” or “telephone”. The frame shall be doweled into the manhole to prevent any movement away from the opening. A #4/0 bare copper ground wire shall penetrate the side wall in the bottom Section of the manhole and shall extend 48 inches inside and outside the manhole. The exterior end of this grounding lead shall be connected to a ¾ inch diameter 10-foot long grounding rod. The interior end of this grounding lead shall be connected to a copper grounding plate. The exposed metal surfaces such as cable rack, metal conduit shall be connected to the grounding plate. Use of a ground rod to penetrate the manhole wall is unacceptable. A sump shall be included in the bottom of each manhole.

B. Mastic joint compound shall be provided and shall be placed in the grooves of the attached Sections.

C. Provide cable support hardware and all supports for all cable, cable splices and cable terminations as required to support cable inside manhole.

PART 3 - EXECUTION

3.1 TRENCH EXCAVATION

A. Comply with the following OSHA Part 1926 – Safety and Health Regulations for Construction, Subpart P - Excavation

1. 1926.650 - Requirements for Open Excavations
2. 1926.651 - Requirements for Specific Excavations
3. 1926.652 – Requirements for Protective Systems
4. 1926.653 - Definitions

B. Before beginning trenching operations, stake out the proposed ductbank routing including trench width and obtain approval from the Owner's representative. After trenching has begun and before any ducts or conduits are placed, notify the Owner's representative so that the trenching and installation may be inspected. Also notify the Owner's representative prior to any placement of concrete for ductbanks, so that he may observe the placement.

C. Excavate to permit installation of the duct bank along the grades shown on the Drawings. Deviations to ductbank depth must have prior approval from the Owner and Engineer.

D. Excavate a trench of sufficient width to allow thorough compacting of the backfill under and around the duct bank. a level sand bed a minimum of 6 inches deep shall be placed in the trench before conduit is installed.

E. Where excavation is in rock, remove all rock to a depth below the grade shown on the Drawings. Rock is defined as material that cannot be ripped or excavated by a backhoe with a one cubic yard bucket with rock teeth. Water shall be continuously pumped out from the trench.

F. The Owner's approval is required for the extent of the trench excavation prior to the duct bank installation. Contractor shall schedule excavation in accordance with the Owner's requirements prior to beginning construction.

G. Provide all necessary bracing and bridging to maintain traffic flow during construction through all areas interrupted by trenching. Provide construction signage, traffic barriers, and warning notices throughout the construction period.

H. Provide all necessary repairs to erosion control measures and reseeding of grass in areas disturbed by trenching.

I. Sheet and brace the excavation as required to prevent caving. The trench width may be increased accordingly. Maintain sheeting until the ductbank has been inspected and backfilled to either a depth of 30-inch minimum over the top of the ductbank or as indicated on Drawings. Leave sheeting and shoring in place where directed by the Owner's representative.

3.2 DUCTBANK INSTALLATION

A. Provide conduit in one complete lot. Partial shipment is not approved.

B. Carefully handle and place all conduits to prevent breakage or other damage. Brace and support all conduits as shown on the Drawings to prevent shifting when concrete is poured. all underground ductbanks under roads and parking lots shall be steel reinforced.

C. Lay conduit in true straight line of a gradual or uniform sweep. Maintain uniform grade between buildings and/or manholes per profile Drawings. Conduits shall be sloped to drain into manholes or buildings where possible at a minimum grade 4 inches per 100 feet. Provide factory made long sweep bends for all bends 15 degrees or more, either horizontal or vertical, unless prior approval is given by Owner to bend conduit in field. Bend radius shall be 48” minimum unless noted otherwise on Drawings.

D. Space ducts or conduits a minimum of 3 inches, or in accordance with Drawings, from adjacent ducts. Place spacers or separators on not greater than 5-foot centers.

E. Stagger joints 6 inches vertically and horizontally in horizontal duct runs and make joints watertight in accordance with manufacturer’s recommendations. Where necessary to cut a tapered end on a duct, make the cut with a tool or lathe designed to cut such a taper to match the taper of the particular duct used.

F. Cleanout conduits as work progresses and securely plug all open ends to prevent water, mud or debris from entering the duct.

G. Prior to acceptance of ductbank by the Owner, the Contractor shall pull an approved mandrel through each conduit witnessed by the Owner's representative. Mandrel must not be less than 12 inches long with a diameter approximately ¼ inch less than the inside diameter of the duct or conduit. Swab all conduits clean immediately before pulling cable.

H. Form conduits into ductbanks as shown on the Drawings. Quantity of spacers shall be as required to insure conduit is supported to maintain a true straight line without sagging. Spacers shall be made of plastic, concrete or a suitable nonmetallic, non-decaying material. conduits shall be secured to the spacers using plastic ties; use of wire is not acceptable.

I. A minimum 10-foot Section of galvanized rigid steel conduit shall be used when ducts enter and terminate in manholes, buildings, concrete walls, or other rigid structures. Provide PVC/rigid steel conduit adapters and rigid steel end bells where the ducts enter and terminate in the manhole, building, concrete walls, or other rigid structures.

J. Concrete forming and placement. Concrete shall be placed in forms within the excavated trench. Top of concrete shall be level. Trowel in additional red dye on top of concrete. Conduits shall be not less than 3 inches from the edge of concrete.

K. Identify the ductbank location with metallic safety tape or vinyl tape with magnetic tracer marked "CAUTION! BURIED HIGH VOLTAGE ELECTRICAL LINE". Tape shall be located 12 inches above the ductbank. Identify each individual conduit as per the schedule in the Drawings. Conduits shall be identified in accordance with 26 05 53 Electrical Identification.

L. Inner ducts shall be pre-lubricated to meet coefficient of friction requirements recommended by manufacturers.

M. Inner duct assembly alignment shall be maintained by internal spacers.

N. PVC inner ducts and PVC outer shell shall expand and contract at the same rate.

3.3 MANHOLE INSTALLATION

A. The excavation for the manhole shall be to a suitable depth to allow for the manhole cover to be slightly elevated above the finished grade to prevent run-off from the entering. The finished grade

material shall be sloped around the manhole collar of frame to prevent adequate cover and support.

B. The site preparation for the manhole shall conform to the manufacturer's recommendations. Generally 3 to 6 inches of stabilize sand and base material shall be spread in the bottom of the excavation. The base material or sand shall be compacted and graded to the proper elevation.

3.4 TRENCH BACKFILLING

A. Backfill using fine material up to 24 inches above the top of the ductbank placed in 6-inch lifts and thoroughly tamped.

B. Consolidate the ductbank fill material under roads or similar traffic areas in such a manner as to provide an unyielding foundation of the paving. Remove all excess materials.

C. Succeeding layers of backfill 18 inches and greater above the ductbank may contain courser materials. Backfill shall be free of all organic material or any other material that would cause subsequent settlement. Maximum size of backfill stone or aggregate shall not exceed 6 inches in its greatest dimension.

D. Surface of backfill shall be safe for vehicular traffic as soon as possible. At the upper 12 inches of the backfill provide an approved moist material, thoroughly compacted by tamping thin lifts (approximately 4 inches per lift). Lay the top layer at the required grade surface.

E. Compact backfill by tamping or other method as approved by the Owner's representative. Maintain compaction at a minimum of 95 percent of the maximum density at optimum moisture content as determined by ASTM D 698. The Owner's representative shall direct which method of consolidation is to be followed on each part of the work.

F. Contractor shall assume full responsibility for any deficiency in quantity of material or filling of depressions caused by settlement of backfill material. Damage to other trade's work caused by settling shall be corrected at the Contractor's expense. Contractor shall assume full responsibility for damages to any underground utility lines or other structure.

G. Dispose of all excess material from the construction site as directed by the Owner. Contractor should remove excess spoils and other material from the site.

3.5 RECORD DRAWINGS

A. Provide all concrete test reports as required per Division 03 specifications.

B. All duct bank locations shall be located with respect to site horizontal controls. All ductbanks shall be located at ends and change of directions. Record accurately all ductbank bends (radius and center point) ±1-foot by 0-inch accuracy on the construction As-Build drawings.

C. Record the installed length of each conduit in the ductbank to the nearest foot and transmit to the Owner's representative.

END OF SECTION