



**University of North Texas
Chilton Hall
Level 1 Renovation**

Project Manual
ISSUE FOR CONSTRUCTION
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PROFESSIONAL CERTIFICATIONS – MECHANICAL, PLUMBING, AND FIRE ALARM

Project: Chilton Hall Renovation

The following Drawings and Technical Specifications have been prepared under the direction of the following professional. The various parts to which their individual responsibilities apply are limited to those identified above their seal:

Drawings – P-series, M-series, FA-series

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01-16-2025



Yaggi Engineering, Inc.
Texas Registration #F-9622
YE Project No. 2321.00

PROFESSIONAL CERTIFICATIONS – ELECTRICAL

Project: Chilton Hall Renovation

The following Drawings and Technical Specifications have been prepared under the direction of the following professional. The various parts to which their individual responsibilities apply are limited to those identified above their seal:

Drawings – E-series, ED-series

Specification Sections in Divisions 26.



01-16-2025



Yaggi Engineering, Inc.

5840 Interstate 20 West, Suite 270

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Texas Registration #F-9622

YE Project No. 2321.00

PROFESSIONAL CERTIFICATIONS – TECHNOLOGY

Project: Chilton Hall Renovation

The following Drawings and Technical Specifications have been prepared under the direction of the following professional. The various parts to which their individual responsibilities apply are limited to those identified above their seal:

Drawings – T-series, TA-series, T- series

Specification Sections in Divisions 27 and 28



01/16/2025

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**SECTION 22 0010
BASIC PLUMBING REQUIREMENTS**

PART 1 - GENERAL

1.01 GENERAL PROVISIONS AND SUPPLEMENTAL GENERAL PROVISIONS

- A. The "General Conditions" and "Supplementary Conditions" are by reference made a part of this section and shall apply to each and every heading as though included herein.
- B. In the event of conflict, the requirements of the "General Conditions" and "Supplementary Conditions" will take precedence over these "General Requirements".

1.02 GENERAL

- A. The Contractor shall provide all plans, labor, equipment, appliances and materials, and shall perform all operations in connection with the installation of the plumbing work in accordance with the Specifications, applicable drawings, and the conditions specified above.
- B. Contractor shall provide all equipment required and usually furnished in connection with such work and systems whether or not specifically mentioned or specifically indicated on the drawings.
- C. Per the 2018 IECC the Mechanical System and Service Hot Water System Commissioning is not required when cooling equipment capacity is less than 480,000 Btuh (40 Tons) and the combined Space Heating and Service Hot Water System heating capacity is less than 600,000 Btuh (50 Tons).

1.03 COMMISSIONING

- A. The Contractor shall provide all system commissioning services as required by section C408 of the applicable edition of the International Energy Conservation Code (IECC). Plumbing systems shall comply with IECC section C403.
- B. Commissioning, as outlined in IECC section C408 shall include the following:
 - 1. A commissioning plan.
 - 2. Water heater(s).
 - 3. Hot water systems balancing.
 - 4. Functional performance testing for all plumbing equipment and controls.
 - 5. A preliminary commissioning report.
 - 6. Final documentation including drawings, O&M manual(s), T&B report, and final commissioning report.

1.04 INSPECTION OF THE SITE

- A. The Contractor shall visit the site, verifying all existing items indicated on drawings and/or specified, and familiarize themselves with the existing work conditions, hazards, grades, actual formations, soil conditions, and local requirements. The submission of bids shall be deemed evidence of such visits.
- B. All proposals shall take these existing conditions into consideration, and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.
- C. The trade furnishing the equipment shall be responsible for notifying the Contractor prior to ordering it, in the event that equipment specified and/or reviewed is incompatible with this requirement.

1.05 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

- A. Refer to other sections of the specifications for construction phasing and time increments.
- B. The Contractor shall obtain and pay for all required utility connections, impact fees, utility extensions and/or relocations and shall pay all costs and inspection fees for all work included herein.

1.06 APPLICABLE CODES AND STANDARDS

- A. 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 the Specifications, except as may be hereinafter modified in these Specifications and associated drawings.
- B. Latest edition of the National Fire Protection Association Standards (NFPA):
 - 1. NFPA No. 70 National Electrical Code
 - 2. NFPA No. 101 Safety to Life from Fire in Buildings and Structures
 - 3. NFPA No. 255 Test of Surface Burning Characteristics of Building Materials
- C. United States of America Standards Institute (ASA) Standards:
 - 1. A40.8 National Plumbing Code
 - 2. B31.1 & B31.1a Code for Pressure Piping
- D. Any Contractor performing plumbing work on UNT property will be in possession of, and provide proof of current State of Texas Plumbing License. Work shall comply with the latest edition of the International Plumbing Code.
- E. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes.
- F. American Society of Testing and Material (ASTM): All applicable manuals and standards.
- G. American Water Works Association (AWWA): All applicable manuals and standards.

- H. National Electrical Manufacturer's Association (NEMA): All applicable manuals and standards.
- I. City and State Building Codes.
- J. State of Texas Occupational Safety Act: Applicable safety standards.
- K. Occupational Safety and Health Act (OSHA).
- L. State of Texas Energy Conservation Construction Code.
- M. All work shall be in accordance with all regulations and requirements of the State of Texas Architectural Barriers Act (TAS).
- N. Refer to Specifications sections hereinafter bound for additional codes and standards.
- O. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. All material shall be listed by the Underwriter's Laboratories, Inc., as conforming to its standards and so labeled in every case where such a standard has been established for the particular type of material in question.
- P. All equipment provided and all installation methods shall meet all applicable requirements of the International Energy Conservation Code.
- Q. 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 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 other specifications of the Contract Documents, providing no work or fabrication of materials has been accomplished in a manner of non-compliance. 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.

1.07 CONTRACT DOCUMENTS

- A. These specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, switch controls, circuits, lines, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
- B. If the Contractor deems any departures from the drawings necessary, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior written acceptance.
- C. There are intricacies of construction that are impractical to specify or indicate in detail; however, in such cases the current rules of good practice and applicable specifications shall govern.
- D. It is the Contractor's responsibility to properly use all information found on the Architectural, Structural, Fire Protection, Plumbing, Mechanical and Electrical drawings where such information affects their work.

- E. All dimensional information related to new structures should 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.
- F. The interrelation of the specifications, the drawings, and the schedules is 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.
- G. Should the drawings or specifications disagree within themselves, or with each other, the better quality of greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Architect in writing, shall be performed or furnished. Figures indicated on drawings govern scale measurements and large-scale details govern small-scale drawings.

1.08 SPACE AND EQUIPMENT ARRANGEMENT

- A. The size of fire protection, plumbing, mechanical, and electrical 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. Shop drawings shall be prepared 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.
- C. Maintain all Code required clearances for equipment access.

1.09 FABRICATION DRAWINGS

- A. Contractor shall submit shop 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, and,
 - 3. Where called for elsewhere in these specifications.
- B. Contractor shall submit piping shop drawings for review by the Architect. Fabrication drawings shall be fully coordinated with ALL other trades and with existing conditions.
- C. All required shop drawings, except as hereinafter specified, shall be prepared at a scale of not less than 1/8 in. equal to 1 ft. for floor plans and 1/4 in. equal to 1 ft. for mechanical rooms.

1.10 SUPERVISION

- A. Each contractor shall keep a competent superintendent or foreman on the job at all times necessary for the timely and proper completion of the work.

- B. It shall be the responsibility of each superintendent to study all drawings and familiarize themselves with the work to be done by other trades. They shall coordinate this work with other trades, and before material is fabricated or installed, make sure that their work will not cause an interference that cannot be resolved without major changes to the drawings. If a conflict between trades arises that cannot be resolved at the jobsite, the matter shall be referred to the Architect for their ruling.

1.11 EXISTING FACILITIES

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by themselves and their workmen, 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, and remove all such temporary protection upon completion of the work. All barricades and safety devices shall be in compliance with OSHA.
- 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 same 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, 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 control system devices, electrical switches, relays, fixtures, piping, conduit, etc.
- E. Outages of services, as required by the new installation, will be permitted only at a time approved by the Architect and Owner's Representative .

1.12 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. 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.
- 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 workmen skilled in the work and in accordance with standard practice of the trades involved.

- C. 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 and sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Architect. 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 of facilities, which must remain in operation during the construction period, shall not be interrupted without prior specific approval of the Architect as hereinbefore specified.
- D. All equipment and materials indicated to be removed and not be re-used shall be disposed of by the Contractor and/or be salvaged as noted. Any items indicated to be salvaged shall be returned to the Owner and Contractor shall Coordinate with Owner where materials are to be stored.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall prepare, in triplicate for the Owner's Manual, complete sets of operating and maintenance instructions, system piping, valving, control and interlock diagrams, manuals, parts lists, etc., for each item of equipment. Include copies of all equipment warranties.
- B. In addition, the Contractor shall provide the services of a competent engineer or a technician acceptable to the Architect to instruct a representative of the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of not less than 4 hours to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, stating the dates of instruction and the personnel to whom instructions were given. The Contractor shall be responsible for proper maintenance until the instructions have been given to the Owner's maintenance personnel.

1.14 GUARANTEE

- A. All work and equipment shall be guaranteed for a period of one year from the date of substantial completion.
- B. Guarantee shall be for all labor and materials.
- C. Certain items for equipment shall have additional or extended warranties when so specified.

1.15 MATERIALS AND WORKMANSHIP

- A. All materials, unless otherwise specified, shall be of current U.S. manufacture, new, free from all defects, 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 present a neat, workmanlike 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 furnishing the proper equipment and/or material, and to see 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.

1.16 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA 255, latest edition. The classification shall not exceed No. 2, with the range of indices between 0 to 25 for these Classifications as listed in the Federal Specifications. Modifications shall be made to insulating materials, etc., as required to comply with the Federal Specification.

1.17 LARGE APPARATUS

- A. Any large piece of apparatus which is to be installed in any space in the building, and which 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.

1.18 FLOOR AND CEILING PLATES

- A. Except as otherwise noted, provide chrome plated brass floor and ceiling plates around all pipes, conduits, ducts, etc., passing exposed through walls, floors, or ceilings, in any spaces, except under floor and attic spaces. 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. Plates will not be required for piping where pipe sleeves extend 3/4 in. above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have plates made to fit accurately at all floor, wall and ceiling penetrations.

1.19 SLEEVES, INSERTS AND FASTENINGS

- A. Proper openings through floors, walls, roofs, etc., for the passage of piping, ductwork, etc., shall be provided. All penetrations must pass through sleeves except soil pipe installed under concrete slabs on fill. 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.
- B. Pipes passing through concrete or cinder walls and floor or other corrosive material shall be protected by a protective sheathing or wrapping or by sleeves, as required to meet the local code. Annular spaces between sleeves and pipes shall be filled or tightly caulked in an approved manner. Annular spaces between sleeves and pipes in fire-resistance-rated assemblies shall be filled or tightly caulked in accordance with the local code.
- C. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeves shall be 1/4 in., except that the minimum clearance shall be 2 in. where piping contacts the ground. Sleeves through walls and partitions shall be installed flush with exposed surfaces. Sleeves through floors shall be extended 2 in. above finished floor.
- D. Above grade and dry location sleeves shall be constructed from 20 to 22 gauge galvanized steel. Sleeves passing through walls or floors on or below grade and/or moist areas such as mechanical rooms shall be constructed of galvanized steel Schedule 40 pipe and shall be designed with suitable flange in the center of the floor or wall to form a waterproof passage. After the pipes have been installed in the sleeves, void space around the pipe shall be sealed with "Link-Seal" modular wall and casing seals as manufactured by Thunderline Corporation.

- E. 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.
- F. Fastening of pipes, conduits, etc., in the building shall be as follows: To wood members - by wood screws; to masonry - by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are acceptable for general use, and will only be permitted where specifically acceptable to the Architect.
- G. Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.
- H. Vermin Proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be sealed with a continuous bead of sealant.
- I. The space around piping, ductwork, etc., penetrating walls, ceilings and floors that define air plenums shall be sealed airtight in an acceptable manner. Ceiling plenums used for return air are considered air plenums.

1.20 ACCESS DOORS

- A. This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed shutoff or service valves, strainers, unions, flow switches, pressure reducing valves, control valves, air terminal units, fire and/or smoke dampers, and other items of concealed mechanical equipment. All access door locations are not shown on the drawings. It is the Contractor's responsibility to provide access doors at all locations required. Ensure alignment of access panels with valves/components to pipe chases and valves above ceilings or otherwise concealed. Under rooms which have reasonable possibilities of water in them, such as restrooms with floor drains, provide access panels in plaster or gypsum board ceilings. Access panels shall not require a special tool to unlock. Provide access to manifolds with integral factory or field-installed valves. Provide enough access to all full-open valves and shutoff valves.
- B. Access doors mounted in painted surfaces shall be equal to 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 surfaces of the adjacent finishes. Access doors mounted on tile surfaces shall be stainless steel materials. Access doors shall be minimum of 24 in. x 24 in. in size, where possible, to comply with UNT Design and Construction Standards.

1.21 CONSTRUCTION REQUIREMENTS

- A. The Architectural, Structural, Fire Protection, Mechanical, Plumbing, and Electrical plans and specifications including the General Provisions, Supplemental General Provisions, and other pertinent documents issued by the Architect, are a part of these specifications and the accompanying fire protection drawings, and shall be complied with in every respect. All the above is included in the Contract Documents, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of architectural, structural and electrical details from the plumbing drawings.

- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.
- C. The Contractor shall be responsible for fitting their material and apparatus into the building and shall carefully lay out their work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation supplied by the manufacturer of the equipment to be installed and thereby to provide an integrated satisfactory operating installation.
- D. The plumbing and associated drawings are necessarily diagrammatic in character and cannot show every connection in detail or every pipe or equipment in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate pipe hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- E. When the plumbing drawings do not give exact details as to the elevation of pipe, ducts, etc., physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner, and the plans do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas. Piping specified to be insulated shall be supported in a manner that will allow the insulation to be installed without gaps. Insulated piping in concealed areas shall be offset with fittings as necessary to permit installation of insulation. Bending of pipes or installing pipes in a strain in order to insulate will not be permitted.
- F. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Equipment shall be so located and installed as to permit convenient and safe maintenance and future replacement. Piping, ductwork, valve stems, etc., shall not block service space.

1.22 PLUMBING SUBMITTALS AND SHOP DRAWINGS

- A. Definitions:
 - 1. Submittal - Equipment, Product Data, and Material Information for components proposed to be installed for the project.
 - 2. Shop Drawing - Scaled floor plans, riser or isometric diagrams, and elevations of proposed component

- B. Refer to the Conditions of the Contract (General and Supplementary) and Division 01 Section: "SUBMITTALS" for submittal definitions, requirements, and procedures.
- C. Submittal and Shop Drawings will be accepted only when submitted by the Contractor. Data submitted from Subcontractors and material suppliers directly to the Architect will not be processed.
- D. Submit Submittals, product data, and samples on items indicated in the individual sections.
- E. Submittals and Shop Drawings shall not be used as requests or proposals for alternate equipment or materials. Refer to Item "Product Options and Substitutions" elsewhere in this section.
- F. THIRD PARTY CERTIFICATION: All Packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70, National Electric Code (NEC), Article 90-7.

1.23 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the Division 01 Section "SUBSTITUTION PROCEDURES" for requirements in selecting products and requesting substitutions.
- B. Standards for Materials:
 - 1. These specifications indicate a standard for all materials incorporated into the work, with manufacturer's names and catalog numbers used to establish a grade and quality of materials and equipment. The manufacturer listed on the equipment schedules, or named first in the specifications, is the one on whose equipment the layout is based. Other named manufacturers must meet the indicated performance and space requirements.
 - 2. The "approved equal" clause used in these specifications is to permit the proposal of unnamed manufacturer's products for the work, and the Architect/Engineer's decision concerning equal products is final.
 - 3. Considerations as to determination of equal products include, but are not limited to, the following:

Materials	Physical size
Workmanship	Weight
Gauges of Materials	Appearance
Available Local Service Personnel	Performance
Previous successful installations	Capacity
Delivery Schedules	Required Equipment Clearances

4. [Shop Drawings must be submitted if proposed equipment differs in physical size than specified equipment to indicate proposed equipment has been coordinated with other trades and space allocated for this equipment. Shop drawings must be at a 1/4" per foot scale indicating proposed equipment layout and any other equipment/materials noted in that general area. Other equipment may include, but is not limited to, HVAC equipment, plumbing equipment, electrical equipment, light fixtures, structural members, cabinetry, etc.]
 5. Failure to submit scaled Shop Drawings will indicate that the Contractor has coordinated their efforts with other trades and finds no conflicts with the work presented in the Contract Documents.
- C. Requests for substitutions for equipment, materials and apparatus listed in Division 22 Sections must be submitted in writing a **MINIMUM OF 10 DAYS** prior to the scheduled bid date. Such requests must be accompanied by complete data to permit proper evaluation.
 - D. BIDS SHALL NOT BE BASED ON UN-APPROVED MATERIALS, EQUIPMENT, OR APPARATUS. UNAPPROVED MATERIAL, EQUIPMENT OR APPARATUS WILL NOT BE ACCEPTED.
 - E. Should electrical, water, drain, natural gas, structural support, or other similar requirements for alternate equipment, whether named in the specifications or approved as a substitution, be different from requirements for the products used in laying out the project, such changes shall be the responsibility of the Contractor, and shall not result in extra charges to the Owner or Architect/Engineer.

1.24 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned for column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.25 PAINTING

- A. Field painting of plumbing equipment, piping systems, etc., shall be accomplished under Division 09 of these specifications.
- B. Protection of Factory-applied Finishes:

1. Factory-applied finishes on equipment and apparatus installed on the project shall be carefully protected.
2. At the conclusion of the work, and prior to final acceptance of the project, equipment and apparatus shall be thoroughly cleaned of all construction dirt, oil and grease smears, temporary labels, debris, paint droppings, etc.
3. Damaged factory finishes shall be restored to their original condition using procedures, materials and application techniques as set forth in Division 09 found elsewhere in these specifications.

1.26 CLEANING

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for general requirements for final cleaning.
- B. Refer to Division 23 Section: "MECHANICAL TESTING, ADJUSTING AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.
- C. Name Plates:
 1. All nameplates shall be protected from damage during the construction process.
 2. At the conclusion of the work, the nameplates shall be carefully cleaned and left in a fully legible condition.
- D. Removal of Rubbish: Each Contractor is responsible for the timely removal of rubbish and trash generated by their work, such as empty cartons, containers, materials crates, etc. Particular attention is called to residue that may present a potential tripping or injury hazard.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

- A. The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer's materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect'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, he shall bear all costs arising in connection with the deficiencies.
- B. The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.
- C. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions.

- D. Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriter's Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers, the Contractor shall submit proof that the items furnished under these sections of the specifications conform to such requirements. The ASME stamp will be acceptable as sufficient evidence that the items conform to the respective requirements.
- E. 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 Observation.
- F. 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 in. 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 coatings 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-6215.
- G. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.
- H. The Contractor shall be responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize themselves with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect 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.

2.02 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. 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, steel treads, and workmen or their tools and equipment shall cover finished surfaces to prevent any damage 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 observation must be cleaned of rust and repainted as specified elsewhere in these specifications.

2.03 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 their work promptly and carefully 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.

2.04 PRECEDENCE OF MATERIALS

- A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the available space, and which will insure complete and satisfactory systems. Each Contractor shall be responsible for the proper fitting of their material and apparatus into the building.
- B. Each Contractor shall so harmonize their work with that of the other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipelines that require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed: See special conditions noted hereinafter for work integrated with structural systems.
 - 1. Building lines
 - 2. Structural members
 - 3. Drain piping
 - 4. Vent piping
 - 5. Steam piping
 - 6. Condensate piping
 - 7. Refrigerant piping
 - 8. Electrical bus duct
 - 9. Supply ductwork
 - 10. Return ductwork
 - 11. Exhaust ductwork
 - 12. Chilled water and heating water piping
 - 13. Automatic Fire Protection Sprinkler Piping

14. Natural gas piping
15. Domestic hot and cold water piping
16. Electrical conduit

2.05 LOCATION OF OUTLETS IN ROOMS

- A. All fire protection, plumbing, acoustical tile, diffusers, grilles, registers, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of acoustical tile panels and other similar panels with respect to the mechanical and electrical outlets and devices. Those mechanical and electrical outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the center of whole tiles. When locations of mechanical and electrical devices shown on the Architect's reflected ceiling plans need to be modified, the final determination of the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect.
- B. The drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with the other trades. The Architect reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.
- C. The Contractor, by submitting a bid on this work, sets forth that he has the necessary technical training and ability, and that he will install their work in a satisfactory and workmanlike manner which is up to the best standards of the trade, complete, and in good working order. If any of the requirements of the drawings and specifications are impossible of performance, or if the installation, when made in accordance with such requirements, will not perform satisfactorily, he shall report it to the Architect for correction promptly after discovery of the discrepancy.

2.06 CONNECTIONS FOR OTHERS

- A. This Contractor shall rough-in for and make all gas, water, steam, sewer, etc., connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in drawings provided by the equipment suppliers, along with 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 where required. In each water line serving an item of equipment or piece of machinery, provide a shut-off 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.

2.07 WALL HUNG CARRIERS

- A. Provide floor mounted carriers for all wall mounted fixtures. Refer to Architectural plans and confirm walls intended to conceal carriers are adequate in depth to provide necessary space and clearance to properly install the carriers.

PART 3 - INSTALLATION

3.01 INSTALLATION METHODS

- A. All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceiling, unless otherwise indicated.
- B. Piping may be run exposed in mechanical rooms, janitors' closets, or storage spaces, but only where necessary. All exposed piping shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.
- C. All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified. Independently support all equipment, conduits, piping, etc. from building structure. Hangers and supports for equipment, piping, and conduits should be double nutted top and bottom.
- D. Where limited space is available above the ceilings and below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, in a manner to provide maximum above-floor clearance. Sleeves shall be as specified or as required.
- E. 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 plans, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces may be run at angles to the construction but shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.
- F. There shall be no pipe joints nearer than 12 in. to a wall, ceiling, or floor penetration, unless pipe joint is the welded type joint.
- G. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Architect and resolve the conflict, prior to erection of any work, in the area involved.

3.02 CUTTING AND PATCHING

- A. Cut and patch openings through walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- B. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills at locations acceptable to the Architect. Impact-type equipment will not be used, except where specifically acceptable to the Architect. Openings in Precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled or cast to exact size.

- C. 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. 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.
- E. 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. No cutting, boring, or excavating, which will weaken the structure, shall be undertaken. NO STRUCTURAL MEMBER MAY BE CUT WITHOUT THE WRITTEN APPROVAL OF THE ARCHITECT, ENGINEER, and OWNER'S REPRESENTATIVE.

3.03 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 plans, but shall 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 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 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 shall be removed. Pipe shall not be permitted to lie on the ground during storage. Pipe ends shall be sealed during storage.

3.04 IDENTIFICATION AND LABELING

- 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.
- B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16 in. thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2 in. 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:
 - 1. Domestic Water Heaters
 - 2. Miscellaneous similar and/or related items.

- C. The Contractor shall install identification tags to be affixed to those valves that have functions that are not obvious. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. The valve identification tags shall be brass discs, 2 in. in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

3.05 TESTS AND INSPECTIONS

- A. The Contractor shall, during the progress of the work and upon its completion, test their work and make all tests as required by the specifications, state, municipal and other authorities having jurisdiction of the work. Piping pressure tests shall be made before pipe is concealed or covered. Tests shall be made in the presence of authorities requiring tests. The Contractor shall pay all costs, inspection charges and fees required for the tests of their work.
- B. The Contractor shall provide all apparatus, temporary piping connection, etc., required for tests. The Contractor shall take all due precautions to prevent damage to the building or its contents incurred by such tests. The Contractor shall repair and make good at their own expense any damage caused by failures or leaks during the tests.
- C. Leaks, defects or deficiencies shall be repaired and/or replaced, and tests shall be repeated until the test requirements are complied with fully.
- D. All equipment shall be placed in operation and tested for proper automatic control before the final balancing of the system is started.
- E. 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 condition, test results, specified results, and any other pertinent data. Data shall be delivered to the Architect.

3.06 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 their tools, equipment and materials and shall clean their debris from the job. Upon the completion of the job, each trade shall immediately remove all of their tools, equipment, any surplus materials and all debris caused by their portion of the work.

3.07 CLEANING AND PAINTING

- A. All equipment, piping, ductwork, grills, insulation, etc., in finished areas furnished and installed by the Contractor shall be painted. Finished areas include mechanical rooms, boiler rooms, and outside the building as well as occupied areas inside the building. Final painting is to be done by the General Contractor. This Contractor shall thoroughly clean all part of materials and equipment of cement, plaster, and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.

- B. This Contractor shall thoroughly clean the finish on all parts of the materials and equipment with factory applied finishes. Exposed parts in equipment rooms, above crawl space slabs, and all other spaces except sealed chases and attics shall be thoroughly cleaned of cement, plaster and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. If the finish has been damaged, the Contractor shall re-paint to the satisfaction of the Architect.
- C. All canvas finishes shall be painted with one sizing coat if not already sized, containing a mildew resistant additive and Arabol adhesive prior to any other specified finish paint.
- D. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during painting operation.

3.08 ELECTRICAL PROVISIONS OF PLUMBING WORK

- A. The extent of electrical provisions to be provided as plumbing work is indicated in other sections of the specifications, on the drawings and as further specified in this section.
- B. Starters, Controllers: In general, plumbing includes furnishing combination starters. Controllers are specifically included as electrical work when mounted in motor control centers. Electrical work includes installation, mounting and wiring of starters and controllers that are furnished as mechanical work. Free standing, large motor controllers shall be set in place, on pads, as plumbing work.
- C. Electrical heating equipment shall be furnished complete with internal or integral fusing and subdivision of loads to comply with the NEC.
- D. Wherever possible, match the elements of the electrical provisions of plumbing work with similar elements of the electrical work specified in electrical sections of the specifications.
- E. Standards:
 - 1. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards to definitions of terminology herein.
 - 2. Comply with National Electrical Code (NFPA No. 70) for installation requirements.
 - 3. Comply with National Electrical Contractors Association (NECA) "Standard of Installation".

3.09 TEMPORARY FACILITIES

- A. Unless noted otherwise in the Supplementary General Conditions; provide temporary facilities.

3.10 EQUIPMENT INSTALLATION REQUIREMENTS

- A. All plumbing equipment shall be furnished and installed complete and ready for use.
- B. Others shall furnish certain kitchen , lab, or Owner process equipment. Contractor shall be responsible for furnishing and installing all items as required to make equipment complete operating systems. The Contractor shall furnish and install all auxiliary piping, valves, controls, control wiring, conduit, alarms, etc., required. All necessary devices, control wiring, conduit, etc., will not necessarily be shown on the drawings.

3.11 OWNER FURNISHED EQUIPMENT

- A. The Contractor's responsibility shall include receiving and installing all Owner-furnished equipment.

END OF SECTION

**SECTION 22 0506
PLUMBING DEMOLITION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Demolition of:
 - 1. Plumbing fixtures and trim, specialties, equipment and associated piping.
 - 2. Fire protection equipment and associated piping.
 - 3. Hanger and support devices.
 - 4. All other appliances or devices associated with equipment or devices to be removed.
- B. Demolition of all power wiring and conduit from each plumbing item to be removed back to the point of supply.

1.02 QUALITY ASSURANCE

- A. Perform all demolition and removal work necessary to arrive at the arrangement shown on the Contract Drawings.
- B. Perform all operations in such a method to cause minimum damage to items to be relocated, salvaged, or to remain intact and in use.

1.03 JOB CONDITIONS

- A. Perform site repair and removal of salvaged items at times approved by the Owner. Accomplish repair and removal of items in a continuous and diligent manner in order to limit interference with Owner's on-going operations.
- B. Drawings may not indicate and specifications may not identify every item required to be moved or removed.
- C. Before submitting bids, visit and examine the site of the work and become familiar with the scope of the work and the details of the demolition work to be accomplished.
- D. Submittal of a bid will be evidence that such an examination has been made and the various details noted.
- E. Claims for extra compensation because of additional labor, materials, or equipment required because of difficulties encountered, will not be recognized unless items were concealed at time of inspection of the Contract Documents. Bring all such items to the attention of the Owner's Representative and the Architect for their disposition before continuing with the work.
- F. Execute demolition work in a manner to protect adjacent equipment and other existing items against damage.
- G. Provide and erect lights, barricades, warning signs, and other items as required for protection of the Owner's employees, building occupants, and the public.

- H. Maintain barricades in good condition throughout the project to substantial completion.
- I. Control the dust resulting from demolition to prevent it from spreading the occupied areas of the building and to avoid creating a nuisance in the immediate surrounding area.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PROTECTION

- A. Provide protection for all building elements, all items which are to remain, all occupants and all workers at all times, and in accordance with all requirements of the Owner.

3.02 PROTECTION OF BUILDING FROM THE WEATHER

- A. Maintain weather protection for the space(s) being worked in at all times, and in accordance with all requirements of the Owner.

3.03 DEMOLITION

- A. Perform demolition in accordance with all requirements of the Owner.

3.04 DISPOSITION OF MATERIALS

- A. Dispose of all demolition items and materials in a legal off-site location.

3.05 RELOCATION AND REUSE OF PLUMBING ITEMS

- A. Relocate items indicated on the Contract Drawings as required to accommodate the new construction. Remove, relocate and reconnect equipment and accessories that are to be reused.
- B. Coordinate the work with the Electrical Contractor. Determine which items and equipment are to remain, to be relocated or to be removed. Perform the work consistent with the scope of the project.
- C. Transport and store materials removed and designated for relocation as directed by the Owner's Representative.
- D. Remove all salvage items not be reused or delivered to the Owner, from the property at the end of each workday.
- E. Maintain full water, drain, electrical service, etc., to all equipment and apparatus that remains in service in the building.

3.06 CLEANING

- A. Section 22 0010 - BASIC PLUMBING REQUIREMENTS.

3.07 REMOVAL OF WATER

- A. Be responsible for the removal of water in areas in which scheduled work is to be performed.

1. Remove water by pumping, siphoning, absorbent mopping, or compressed air brooming.
2. Do not use any method of removal that will cause damage to new or reused adjacent equipment or materials.

3.08 SCHEDULING

- A. Schedule demolition in strict compliance with the Owner's instructions.

3.09 DISCONNECTION AND RECONNECTION OF UTILITIES

- A. Do not disconnect or reconnect any utilities until notifying the Owner's Representative.
- B. Notify the Electrical Contractor when requiring Electrical Disconnect or Reconnect.

END OF SECTION

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**SECTION 22 0512
PLUMBING AND ELECTRICAL COORDINATION**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Refer to Section 21 00 10 - BASIC FIRE PROTECTION REQUIREMENTS.
- C. Refer to Section 22 0010 - BASIC PLUMBING REQUIREMENTS.
- D. Refer to Section 23 0010 - BASIC MECHANICAL REQUIREMENTS.

1.02 SUMMARY

- A. This Section describes the coordination between the Fire Protection, Plumbing, Mechanical and Electrical portions of the work.
- B. This Section is included under the Division 21 portion of the Specifications as Section 21 05 12, under the Division 22 portion of the Specifications as Section 22 0512, under the Division 23 portion of the Specifications as Section 23 0512, and under the Division 26 portion of the Specifications as Section 26 05 12.

1.03 WORK INCLUDED

- A. Responsibility: Unless otherwise indicated, motors and controls shall be furnished, set in place and wired in accordance with the following schedule. **This schedule may include equipment and systems that are not required for this project. Only the equipment and systems that are required on the drawings and/or specified elsewhere will be required by this section:**

	ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
1.	Equipment Motors	21/22/23	21/22/23	26
2.	Magnetic Motor Starters			
	a. Automatically controlled, with or without HOA switches	21/22/23	26	Notes 1,3,5
	b. Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	21/22/23	22/23	Notes 1,3,5
	c. Manually controlled	21/22/23	26	Notes 1,3,5
	d. Manually controlled and furnished as part of factory wired equipment	21/22/23	26	Notes 1,3,5

	ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
	e. Furnished in Motor Control Centers	26	26	Notes 1,3,5
3.	Variable Speed (Frequency) AC Drives	22/23	26	Notes 1,4,5
4.	Line voltage thermostats, time clocks, etc., not connected to control panel systems	23	26	23
5.	Electric thermostats, time clocks, remote bulb thermostats, motorized valves, float controls, etc. which are an integral part or directly attached to ducts, pipes, etc.	22/23	22/23	22/23
6.	Temperature control panels and time switches mounted on temperature control panels	23	23	23
7.	Motorized valves, motorized dampers, solenoid valves, EP and PE switches, etc.	23	23	Note 1
8.	Alarm bells furnished with equipment installed by Division 22 or 23	22/23	22/23	22/23
9.	Wiring to obtain power for control circuits, including circuit breaker	21/22/23	21/22/23	21/22/23
10.	Low voltage controls	21/22/23	21/22/23	21/22/23
11.	Fire protection system (sprinkler) controls	21	21	Note 8
12.	Fire and smoke detectors installed on mechanical units and in ductwork	28	23	Note 8
13.	All relays required for fan shutdown, motorized dampers, smoke control devices, and other items integral with HVAC equipment to provide operation and control of HVAC equipment	23	23	Note 1
14.	Smoke dampers, and combination fire/smoke	23	23	Note 7

	ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
	dampers			
15.	Boiler and water heater controls, boiler burner controls panels	22/23	22/23	22/23
16.	Pushbutton stations, pilot lights	22/23	22/23	22/23
17.	Heat Tape	21/22/23	21/22/23	26
18.	Disconnect switches, manual operating switches furnished as a part of the equipment	21/22/23	21/22/23	Notes 1,5
19.	Disconnect switches, manual operating switches furnished separate from equipment	26	26	26
20.	Multispeed switches	23	23	26
21.	Thermal overloads	21/22/23	21/22/23	21/22/23
22.	Control relays, transformers	21/22/23	21/22/23	21/22/23
23.	Refrigeration cycle, cooling tower and controls	23	23	23
24.	Tamper switches for fire protection (sprinkler) system	21	21	28
25.	Flow and/or pressure switches for fire protection (sprinkler) system	21	21	28
26.	Fire and jockey pump controllers and automatic transfer switch	21	21	Note 6
27.	Alarm bells or horns for fire protection (sprinkler) system	21	21	28
28.	Generator (underground) fuel tank	22	22	--
29.	Generator fuel level indicator	22	22	26
30.	Generator fuel piping from tank to generator	22	22	--
31.	Underground fuel tank leak detection and monitoring system	22	22	22
NOTES:	(1)	Power wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 26; control wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 21/22/23.		

(2)	Wiring from alarm contacts to alarm systems provided by Division 26, wiring from auxiliary contacts to air handling system controls provided by Division 23. Division 26 shall provide power to smoke detector. Smoke detectors required for all air handling systems 2000 CFM or greater. Refer to other Division 23 specifications, Division 26 and Drawings for more specific requirements.
(3)	For requirements for Magnetic Motor Starters, refer to Section 23 89 65 - MOTOR CONTROLLERS.
(4)	For requirements for Variable Speed (Frequency) AC drives, refer to Section 23 89 65 - MOTOR CONTROLLERS.
(5)	Disconnect switches, operating switches, starters and other similar items that are factory-mounted, as a part of complete assembly, shall comply with applicable provisions of the National Electric Code. All such disconnect switches shall be fused.
(6)	Power wiring from energy source to controllers and automatic transfer switch provide shall be provided under Division 26. Interconnection power and control wiring from controllers and automatic transfer switch to pumps shall be provided under Division 21, 22 or 23 and conforming to Division 26 specifications. Control wiring from automatic transfer switch to generator starter shall be provided under Division 26.
(7)	Division 26 will provide power to all smoke and combination fire/smoke dampers, and Division 28 will provide control for all such dampers using area smoke detectors.
(8)	Wiring for sprinkler system controls to be provided by Division 21. Wiring from devices to Fire Alarm System to be provided by Division 28.

B. Connections: Make all connections to controls that are directly attached to ducts, piping and mechanical equipment with flexible connections.

C. PRECEDENCE

1. In general, piping systems that require a stated grade for proper operation shall have precedence over other systems.
2. Precedence for pipe, conduit and duct systems shall be as follows.
 - a. Building lines
 - b. Structural members
 - c. Soil and drain piping
 - d. Vent piping
 - e. Steam piping
 - f. Condensate piping
 - g. Refrigerant piping

- h. Electrical bus duct
 - i. Supply ductwork
 - j. Return ductwork
 - k. Exhaust ductwork
 - l. Chilled water and heating water piping
 - m. Automatic Fire Protection Sprinkler Piping
 - n. Natural gas piping
 - o. Domestic hot and cold water piping
 - p. Electrical conduit
3. Lighting Fixtures shall have precedence over air grilles and diffusers.

D. FINAL INSPECTION AND REPORT

1. At the completion of the work, there shall be a meeting of the Fire Protection, Plumbing, Mechanical, Electrical Fire Alarm and Temperature Control Contractors, representatives of mechanical and electrical equipment manufactures whose equipment was actually installed on the project, and similarly-involved individuals, who shall thoroughly inspect all systems, and who shall mutually agree that all equipment has been properly wired and installed, and that all temperature and safety controls are properly functioning. A written report of this meeting, listing those in attendance, and the companies that they represent, shall be filed with the Owner and Architect or Engineer.

END OF SECTION

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**SECTION 22 0519
PLUMBING METERS AND GAUGES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of meters and gauges required by this section is indicated on Drawings and/or specified in other Division 22 sections.
- B. Types of meters and gauges specified in this section include the following:
 - 1. Temperature Gauges and Fittings.
 - a. Glass Thermometers.
 - b. Thermometer Wells.
 - c. Temperature Gauge Connector Plugs.
 - 2. Pressure Gauges and Fittings.
 - a. Pressure Gauges.
 - b. Pressure Gauge Cocks.
 - c. Pressure Gauge Connector Plugs.
 - 3. Flow Measuring Meters.
 - a. Calibrated Balance Valves.
- C. Gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 sections.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.
 - 2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.
- C. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
- B. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 GLASS THERMOMETERS

- A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9 in. long.
- C. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
- D. Tube and Capillary: Glycerin filled, magnifying lens, 1 percent scale range accuracy, shock mounted.
- E. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
- F. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.
- G. Range: Conform to the following:
 - 1. Hot Water: 30° - 240°F with 2°F scale divisions (0° - 160°C) with 2°C scale divisions).
- H. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following, or approved equal.
 - 1. Ernst Gage Co.
 - 2. Marshalltown Instruments, Inc.
 - 3. Trerice (H.O.) Co.
 - 4. Weiss Instruments, Inc.
 - 5. Weksler

2.02 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2-in. extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

- B. Manufacturer: Same as thermometers.

2.03 TEMPERATURE GAUGE CONNECTOR PLUGS

- A. General: Provide temperature gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Construct of brass and finish in nickel-plate, equip with 1/4 in. NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8 in. O.D. probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.
- B. Manufacturer: Subject to compliance with requirements, provide temperature gauge connector plugs of one of the following, or approved equal:
 - 1. Peterson Equipment Co.
 - 2. Watts Regulator Co.

2.04 PRESSURE GAUGES

- A. General: Provide liquid filled pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Type: General use, glycerin - filled, magnifying lens, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Drawn steel or brass, glass lens, liquid filled 4+ in. diameter.
- D. Connector: Brass with 1/4 in. male NPT. Provide protective siphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
 - 1. Vacuum: 30 in. Hg - 15 psi.
 - 2. Water: 0 - 100 psi.
 - 3. Steam: 0 - 200 psi.
- G. Manufacturer: Subject to compliance with requirements, provide pressure gauges of one of the following, or approved equal:
 - 1. Ametek/U.S. Gauge.
 - 2. Marsh Instrument Co.; Unit of General Signal.
 - 3. Marshalltown Instruments, Inc.
 - 4. Trerice (H.O.) Co.
 - 5. Weiss Instruments, Inc.

2.05 PRESSURE GAUGE COCKS

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4 in. female NPT on each end, and "T" handle brass plug.
- B. Siphon: 1/4 in. straight coil constructed of brass tubing with 1/4 in. male NPT on each end.
- C. Snubber: 1/4 in. brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
- D. Manufacturer: Same as for pressure gauges.

2.06 PRESSURE GAUGE CONNECTOR PLUGS

- A. General: Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Construct of brass and finish in nickel-plate equip with 1/2 in. NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8 in. O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.
- B. Manufacturer: Subject to compliance with requirements, provide pressure gauge connector plugs of one of the following, or approved equal:
 - 1. Peterson Equipment Co.
 - 2. Watts Regulator Co.

2.07 CALIBRATED BALANCE VALVES

- A. General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicate degree of closure of precision-machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.
- B. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves of one of the following, or approved equal:
 - 1. Bell & Gossett ITT; Fluid Handling Div.
 - 2. Taco, Inc.
 - 3. Thrush Products, Inc.
 - 4. Griswold.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At outlet of each hot water circulation pump.
 - 2. At inlet and outlet of each tank type water heater.
- C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.
- D. Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.03 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
 - 1. At suction and discharge of each pump.
- C. Pressure Gauge Cocks: Install in piping tee with snubber. Install siphon for steam pressure gauges.
- D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

3.04 INSTALLATION OF FLOW MEASURING METERS

- A. General: Install flow measuring meters on piping systems located in accessible locations at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated.
 - 1. At discharge of each pump.
- C. Calibrated Balance Valves: Install on piping with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to 3 pipe diameters upstream of valve.

3.05 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION

**SECTION 22 0529
PLUMBING SUPPORTS AND ANCHORS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of supports and anchors required by this section is indicated on Drawings and/or specified in other Division 22 sections.
- B. Types of supports and anchors specified in this section include the following:
 - 1. Pipe and equipment hangers, supports, and anchors.
 - 2. Equipment bases.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 sections.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
 - 2. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - b. Select and apply pipe hangers and supports, complying with MSS SP-69.
 - c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
 - d. Terminology used in this section is defined in MSS SP-90.
- C. All hangers, supports and attachments shall be manufactured with materials compatible with the environment in which they will be installed. Unless directed otherwise, all hangers, supports, and attachments installed exterior to the building or within high humidity environments shall be galvanized steel or stainless steel.
- D. Manufacturers of Hangers and Supports:
 - 1. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. B-Line Systems Inc. (Cooper)
 - b. ANVIL International

1.03 SUBMITTALS

- A. Submit product data and maintenance data as required under provisions of Division 01 and Section 22 0010.
- B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor.
- C. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 HORIZONTAL-PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
- B. Adjustable Steel Clevis Hangers: MSS Type 1.
- C. Yoke Type Pipe Clamps: MSS Type 2.
- D. Steel Double Bolt Pipe Clamps: MSS Type 3.
- E. Steel Pipe Clamps: MSS Type 4.
- F. Pipe Hangers: MSS Type 5.
- G. Adjustable Swivel Pipe Rings: MSS Type 6.
- H. Adjustable Steel Band Hangers: MSS Type 7.
- I. Adjustable Band Hangers: MSS Type 9.
- J. Adjustable Swivel Rings, Band Type: MSS Type 10.
- K. Split Pipe Rings: MSS Type 11.
- L. Extension Split Pipe Clamps: MSS Type 12.
- M. U-Bolts: MSS Type 24.
- N. Clips: MSS Type 26.
- O. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
 - 1. Plate: Unguided type.

- 2. Plate: Guided type.
- 3. Plate: Hold-down clamp type.
- P. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
- Q. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.
- R. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.
- S. Single Pipe Rolls: MSS Type 41.
- T. Adjustable Roller Hangers: MSS Type 43.
- U. Pipe Roll Stands: MSS Type 44.
- V. Pipe Rolls and Plates: MSS Type 45.
- W. Adjustable Pipe Roll Stands: MSS Type 46.

2.02 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
- B. Two-Bolt Riser Clamps: MSS Type 8.
- C. Four-Bolt Riser Clamps: MSS Type 42.

2.03 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
- B. Steel Turnbuckles: MSS Type 13.
- C. Steel Clevises: MSS Type 14.
- D. Swivel Turnbuckles: MSS Type 15.
- E. Malleable Iron Sockets: MSS Type 16.
- F. Steel Weldless Eye Nuts: MSS Type 17.

2.04 BUILDING ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
- B. Top Beam C-Clamps: MSS Type 19.
- C. Side Beam or Channel Clamps: MSS Type 20.
- D. Center Beam Clamps: MSS Type 21.
- E. Welded Beam Attachments: MSS Type 22.
- F. C-Clamps: MSS Type 23.
- G. Top Beam Clamps: MSS Type 25.
- H. Side Beam Clamps: MSS Type 27.
- I. Steel Beam Clamps W/Eye Nut: MSS Type 28.
- J. Linked Steel Clamps W/Eye Nut: MSS Type 29.
- K. Malleable Beam Clamps: MSS Type 30.
- L. Steel Brackets: One of the following for indicated loading:
 - 1. Light Duty: MSS Type 31, suspending 750 lbs. max.
 - 2. Medium Duty: MSS Type 32, suspending 1500 lbs. max.
 - 3. Heavy Duty: MSS Type 33, suspending 3000 lbs. max.
- M. Side Beam Brackets: MSS Type 34.
- N. Plate Lugs: MSS Type 57.
- O. Horizontal Travelers: MSS Type 58.

2.05 CONCRETE INSERTS

- A. Cast-In-Place Spot Type: Malleable iron, or steel with recommended insert nut. Size inserts nut to suit threaded hanger rod. MSS SP-69, Type 18.
- B. Drill-In Spot Type: Steel, attached wedge, lock washer and nut. Size inserts to suit threaded hanger rod.
 - 1. Acceptable Manufacturers and Models:
 - a. Hilti "Kwik Bolt"

- b. Ramset "Wedge Anchor"
 - c. Rawl "Stud"
- C. Continuous Channel Type: Steel, anchoring lugs, with channel nuts, rated for 2000 lbs. per foot minimum load. Size channel nut to suit threaded hanger rod.
- 1. Acceptable Manufacturers and Models:
 - a. B-Line B22
 - b. Elcen 1150
 - c. Unistrut P3200

2.06 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: Constructed of 360° insert of high density, 125-psi compressive strength, and water-proofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.
 - 1. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.

2.07 SPRING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.
- B. Restraint Control Devices: MSS Type 47.
- C. Spring Cushion Hangers: MSS Type 48.
- D. Spring Cushion Roll Hangers: MSS Type 49.
- E. Spring Sway Braces: MSS Type 50.

- F. Variable Spring Hangers: MSS Type 51; preset to indicated load and limit variability factor to 25%.
- G. Variable Spring Base Supports: MSS Type 52; preset to indicated load and limit variability factor to 25%; include load flange.
- H. Variable Spring Trapeze Hangers: MSS Type 53; preset to indicated load and limit variability factor to 25%.
- I. Constant Supports: Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.
 - 1. Horizontal Type: MSS Type 54.
 - 2. Vertical Type: MSS Type 55.
 - 3. Trapeze Type: MSS Type 56.

2.08 MANUFACTURERS OF HANGERS AND SUPPORTS

- A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - 1. B-Line Systems Inc.
 - 2. ITT Grinnell Corp.

2.09 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Auxiliary Steel: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
- E. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.10 SLEEVES, INSETS AND FASTENINGS

- A. Pipes passing through concrete or cinder walls and floor or other corrosive material shall be protected by a protective sheathing or wrapping or by sleeves, as required to meet the local code. Annular spaces between sleeves and pipes shall be filled or tightly caulked in an approved manner. Annular spaces between sleeves and pipes in fire-resistance-rated assemblies shall be filled or tightly caulked in accordance with the local code.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at all changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Install additional at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at all changes in direction of piping. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports that are copper plated, or by other recognized industry methods.

- E. Support and laterally brace vertical pipe runs at every floor level and at intervals not to exceed 20 ft. 0 in. Support vertical pipe with riser clamps installed below hubs, couplings or lugs welded to the pipe.
- F. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- G. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Piping hangers shall be sized large enough to allow insulation to pass through. Hangers for piping 2-1/2 in. and greater shall be provided with pipe covering protection saddle, or high compressive strength insulation saddle. Hangers for piping 2 in. and less shall be provided with pipe covering shields. On cold or chilled water piping provide vapor barrier through hanger.
 - 3. Do NOT utilize "pipe size" hangers with insulation placed over the pipe and hanger.
- H. Unless directed otherwise, all hangers, supports, and attachments installed exterior to the building or within high humidity environments shall be galvanized steel or stainless steel.

3.05 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.06 ADJUSTING AND CLEANING

- A. Hanger Adjustments: Adjust hangers so as to distribute loads equally on attachments.

- B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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**SECTION 22 0553
PLUMBING IDENTIFICATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of mechanical identification work required by this section is indicated on Drawings and/or specified in other Division 22 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Plastic Pipe Markers.
 - 2. Valve Tags.
 - 3. Valve Schedule Frames.
 - 4. Engraved Plastic-Laminate Signs.
- C. Plumbing identification furnished as part of factory-fabricated equipment, is specified as part of equipment assembly in other Division 22 sections.
- D. Refer to other Division 22 sections for identification requirements at central-station mechanical control center; not work of this section.
- E. Refer to Division 21, 23 and 26 sections for identification requirements of fire protection, mechanical and electrical work; not work of this section.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2 in. x 11 in. bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 01.

- C. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 1. Allen Systems, Inc.
 2. Brady (WHO) Co.; Signmark Div.
 3. Industrial Safety Supply Co., Inc.
 4. Seton Name Plate Corp.

2.02 IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.03 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, and pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- C. Insulation: Furnish 1 in. thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on un-insulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2 in. beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6 in. (including insulation if any), provide full-band pipe markers, extending 360° around pipe at each location, fastened by one of the following methods:
 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 in. wide; full circle at both ends of pipe marker, tape lapped 1-1/2 in.
- E. Large Pipes: For external diameters of 6 in. and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 in. wide; full circle at both ends of pipe marker, tape lapped 3 in.
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Lettering: Manufacturer's standard pre-printed nomenclature that best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.
- G. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.04 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4 in. high letters and sequenced valve numbers 1/2 in. high, and with 5/32 in. hole for fastener.
1. Provide 1+ in. diameter tags, except as otherwise indicated.
 2. Provide size and shape as specified or scheduled for each piping system.
 3. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16 in. thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 in. center hole to allow attachment.

2.05 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.06 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16 in. for units up to 20 sq. in. or 8 in. length; 1/8 in. for larger units.

- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.07 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
 - 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification that indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces that require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near each valve, fitting, and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced intermediately at maximum spacing of 20 ft. along each piping run, except reduce spacing to 10 ft. in congested areas of piping and equipment.
 - 7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Piping Identification:

System	Background Color	Text Color
Domestic Cold Water	Green	White
Domestic Hot Water	Yellow	Black
Domestic Hot Water - Recirculated	Yellow	Black
Natural Gas	Yellow	Black
Storm Drain	Green	White

3.03 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
1. Tagging Schedule: Comply with requirements of "Valve Tagging Schedule" at end of this section.
- B. Mount valve schedule frames and schedules in mechanical rooms where indicated or, if not otherwise indicated, where directed by Architect and Owner's Representative.
1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.04 PLUMBING EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 2. Meters, gauges, thermometers and similar units.
 3. Water heaters.
 4. Strainers, filters and similar equipment.
- B. Optional Sign Types: Where lettering larger than 1 in., height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1/4 in. for distances up to 6 ft. 0 in., and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 - 1. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticize tags in lieu of engraved plastic signs.

3.05 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device, which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.06 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 - 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION

**SECTION 22 0593
PLUMBING TESTING, ADJUSTING AND BALANCING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Adjust and balance plumbing hot water recirculation systems
- B. Check each piece of operating equipment provided under Division 22.
- C. Provide Balancing Report

1.02 QUALITY ASSURANCE

- A. Independent Subcontractor: All testing, adjusting and balancing shall be performed by a Testing, Adjusting and Balancing firm that is independent from the plumbing systems installer.
- B. Balancing Work: Under direct supervision of AABC accredited testing organization certified supervisor.

1.03 REFERENCES

- A. Reference Standards: Comply with AABC National Standards for Total System Balance, latest edition.

1.04 SUBMITTALS

- A. Certificate: Before beginning work, submit certification of AABC certified supervisor and AABC firm certification in accordance with Section 22 0010.
- B. Balancing Report: At completion of work, submit balancing report in accordance with Section 22 0010. After adjustments have been made submit three (3) copies of a complete detailed report on mechanical systems and their operation to include:
 - 1. Blackline prints with balance valves marked to correspond with data sheets and with thermometer locations clearly marked.
 - 2. Data sheets showing amount of water at balance valves, instrument used.
 - 3. Operating data including pump RPM, measured motor current and voltage BHP and flow (GPM).
 - 4. Equipment and operating data including water temperatures entering and leaving the thermostatic mixing valve(s).
 - 5. A statement outlining any abnormal or notable conditions not covered in above data. Make special note of any discrepancies between tabulated data and specified conditions.

1.05 PROJECT CONDITIONS

- A. Existing Conditions: Verify following conditions before proceeding with work:

1. Installation of the designated system is complete and in full operation.

PART 2 - PRODUCTS

2.01 INSTRUMENTS

- A. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations and requirements of AABC.
- B. Calibration histories for each instrument shall be available for examination.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect preceding work in accordance with Section 22 0010 - BASIC PLUMBING REQUIREMENTS.

3.02 PREPARATION

- A. Water Systems:
 1. Check:
 - a. Strainers are clean.
 - b. Automatic control valves operation.
 - c. Pump rotation.
 - d. Other conditions as required.

3.03 ADJUSTING AND BALANCING

- A. General: Check, adjust and balance hot water recirculation system to meet the design performance and tabulate results on acceptable forms. Minimum data to include amperage, voltage input, and thermal heater capacity of each pump, equipment nameplate data and operating speed, pressure rise across each pump, GPM capacity of each balance valve.
- B. Test Run: In order to determine that the system installation is complete and will operate satisfactorily, make a test run with equipment operating per normal temperature control schedule and sequence. Run test and operate and adjust equipment as may be required during test run.

3.04 COMPLETION SERVICES

- A. Final Check: Make final checks and do any rebalancing as directed.
- B. Report: Submit Balancing Report as specified above.
- C. Acceptance: Final acceptance of the project will not be made until a satisfactory report is received. Owner reserves the right to spot check the report by field verification prior to final acceptance.

END OF SECTION

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**SECTION 22 0716
PLUMBING PIPING INSULATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of plumbing insulation required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass.
 - 2. Equipment Insulation:
 - a. Fiberglass.
- C. Refer to Section 22 0529 - PLUMBING SUPPORTS AND ANCHORS for protection saddles, protection shields, and thermal hanger shields; not work of this section.
- D. Refer to Section 22 0553 - PLUMBING IDENTIFICATION for installation of identification devices for piping and equipment; not work of this section.

1.02 REFERENCES

- A. North American Commercial and Industrial Insulation Standards. 9th Edition or Latest Edition. Published by Midwest Insulation Contractors Association (MICA).
- B. NAIMA CI228 Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation 33°F to 60°F (0.5°C to 15.6°C) First Edition, 2015. Published by North American Insulation Manufacturers Association (NAIMA).
- C. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.
- D. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
- F. ASTM C335 Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
- G. ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- H. ASTM C547 Standard Specifications for Mineral Fiber Pipe Insulation.
- I. ASTM C585 Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for nominal sizes of Pipe and Tubing (NPS System).
- J. ASTM C795 Standard Specifications for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

- K. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- L. ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Flame/Smoke Ratings: Provide composite mechanical (insulating material, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (UL723) method.
 - 1. Exception: Outdoor mechanical insulation may have flame-spread index of 75 and smoke developed index of 150.
 - 2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame-spread index of 75 and smoke developed index of 150.
- D. Insulations shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or poly-brominated diphenyl ether fire retardants.
- E. Fiberglass insulations shall have a minimum of 50 percent recycled glass content; certified and UL validated.
- F. Fiberglass insulations shall have a bio-based, formaldehyde-free binder and be UL GREENGUARD gold certified.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Fiberglass Products:
 - a. Knauf Insulation
 - b. Manson Insulation
 - c. Owens / Corning
 - d. Johns Manville
 - 2. PVC Fitting Covers / Jacket:
 - a. Proto LoSmoke PVC
 - b. Johns Manville Zeston PVC
 - 3. Coatings, Sealants, and Adhesives:
 - a. Childers Products / H.B. Fuller Construction Products
 - b. Foster Products / H.B. Fuller Construction Products
 - c. Vimasco Corporation
 - d. Mon-Eco Industries

2.02 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Type 1 unless otherwise indicated.
- B. Jackets for Piping Insulation: ASTM C 921 and ASTM C 1136, Type I (Vapor Barrier) for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installer's option.
 - 1. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations, ASTM D 1784.
 - 2. Encase exterior piping insulation with aluminum jacket with weather-proof construction, ASTM C 1729.
- C. Staples, Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
- D. Adhesives, Sealers and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.03 EQUIPMENT INSULATION MATERIALS

- A. Rigid Fiberglass Equipment Insulation: ASTM C 612, Type 1A.
- B. Flexible Fiberglass Equipment Insulation: ASTM C 553, Type I
- C. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
- D. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
 - 1. Encase exterior equipment insulation with aluminum jacket with weatherproof construction, ASTM C 1729.
- E. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Thickness of insulation shall be as recommended by the manufacturer for the temperatures and pipe sizes involved, and in accordance with standards of North American Insulation Manufacturers Association (NAIMA).

3.02 PLUMBING PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.
- B. Cold Piping:
 - 1. Application Requirements: Insulate the following cold plumbing piping systems:
 - a. Potable cold water piping.
 - 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 1 in. thickness; ½ in. thick for condensate drain piping.
- C. Hot Piping:
 - 1. Application Requirements: Insulate the following hot plumbing piping systems:

- a. Potable hot water piping.
 - b. Potable hot water recirculating piping.
2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass (Above Ground Only): 1 in. thick for pipe sizes up to and including 1-1/4 in., 1-1/2 in. thick for pipe sizes 1-1/2 in. and larger.
 - b. All insulation requirements shall comply with applicable edition of IECC.

3.03 EQUIPMENT INSULATION

- A. Hot Equipment (Above Ambient Temperature):
 1. Application Requirements: Insulate the following hot equipment:
 - a. Water heaters.
 2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 2 in. thick, except 3 in. thick for low-pressure boilers and steam-jacketed heat exchangers.

3.04 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-retarder jackets on pipe insulation, and protect to prevent puncture or other damage. All penetrations of the jacket and exposed ends of insulation shall be sealed with vapor barrier coating.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

- H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 in. wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 in. wide vapor barrier tape or band.
- I. Do NOT insulate over pipe hangers. If pipe hangers for piping to be insulated are not adequately sized for insulation to pass through the hanger, notify the General Contractor and Architect.

3.05 INSTALLATION OF EQUIPMENT INSULATION

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices detailed by the North American Commercial and Industrial Insulation Standards manual (latest edition).
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-retarder on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment, breechings, or stacks while hot.
- E. Apply insulation using staggered joint method for double layer construction, where feasible. Apply each layer of insulation separately.
- F. Coat insulated surfaces with layer of insulating cement, trowelled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 in. Apply over vapor barrier where applicable.
- H. Do not insulate boiler manholes, hand-holes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- I. Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

3.06 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.07 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.

- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

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**SECTION 22 1000
PLUMBING PIPING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of Plumbing Piping Work required by this section is indicated on Drawings and by requirements of this section.
- B. Types of Plumbing Piping systems specified in this section include the following:
 - 1. Sanitary waste and vent system.
 - 2. Domestic water system.

1.02 REFERENCES

- A. ANSI/ASME B16.18 - Cast Copper Alloy Solder - Joint Pressure Fittings.
- B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 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 Sec. 9 - Welding and Brazing Qualifications.
- G. ANSI/ASTM B32 - Solder Metal.
- H. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- I. ANSI/ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- J. ANSI/AWS D1.1 - Structural Welding Code.
- K. AWS D10.12 - Recommended Practices and Procedures for Welding Plain Carbon Steel Pipe.
- L. AWS D10.9 - Qualifications and Procedures for Piping and Tubing Welding.
- M. AWS B3.0 - Welding Procedure and Performance Qualification.
- N. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- O. ANSI/AWWA C110 - Ductile Iron and Gray Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
- P. ANSI/AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.

- Q. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- R. ASME - Boiler and Pressure Vessel Code.
- S. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- T. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- U. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
- V. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- W. ASTM A888/ CISPI Standard 301 for Cast Iron hubless pipe and fittings.
- X. ASTM B88 - Seamless Copper Water Tube.
- Y. ASTM B306 - Copper Drainage Tube (DWV).
- Z. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- AA. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings.
- BB. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- CC. ASTM C 1540 - Heavy Duty Shielded Hubless Couplings
- DD. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
- EE. ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings.
- FF. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
- GG. ASTM D2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-flow Applications.
- HH. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
- II. ASTM D2665 - Poly (Vinyl Chloride) (PVC) Plastic Drain Waste and Vent Pipe and Fittings.
- JJ. ASTM D2680 - Acrylonitrile - Butadiene - Styrene (ABS) Composite-Sewer Piping.
- KK. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.
- LL. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- MM. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVS) Pipe and Fittings.
- NN. ASTM D3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

- OO. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- PP. ASTM E84 - Standard test method for surface burning characteristics of building materials.
- QQ. ASTM F477 - Electrometric Seals (Gaskets) for Joining Plastic Pipe.
- RR. ASTM F876 - Cross-linked Polyethylene (PEX) tubing.
- SS. ASTM F877 - Cross-linked Polyethylene (PEX) plastic hot and cold water distribution systems.
- TT. ASTM F1807 - Specification for metal insert fittings utilizing a copper crimp ring for SDR9 Cross-linked Polyethylene (PEX) tubing.
- UU. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing.
- VV. ASTM F2023 - Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Pipe, Tubing and Systems to Hot Chlorinated Water
- WW. ASTM F2657 - Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing
- XX. AWS A5.8 - Brazing Filler Metal.
- YY. AWWA C651 - Standard for Disinfecting Water Mains.
- ZZ. AWWA C904 Standard for Crosslinked Polyethylene (PEX) Pressure Pipe, 1/2 in. Through 3 in., for Water Service.
- AAA. AWWA C601 - Standard Methods for the Examination of Water and Waste Water.
- BBB. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- CCC. CISPI 310 - Couplings for Use with Hubless Cast Iron Soil Pipe and Fittings.
- DDD. ASTM D2564 - Solvent Cements for Poly (vinyl) (chloride) (PVC) Plastic Pipe and Fittings.
- EEE. NFPA 24 - Installation of private fire service mains and their Appurtenances, latest edition.
- FFF. NFPA 54 - National Fuel Gas Code, latest edition.
- GGG. ANSI LC-1 / CSA 6.26 - Use and Installation of Corrugated Stainless Steel Tubing (CSST).

1.03 QUALITY ASSURANCE

- A. Plumbing Certification: Persons performing plumbing work shall have a current Texas State Plumbing License.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Conform to ASME Code and AWS 10.12.

- D. Welders Certification: In accordance with ANSI/ASME Sec. 9 or AWS D1.1, AWS D10.9, and AWS B3.0, as applicable.
- E. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the engineer.
- F. All adhesives, sealants and sealant primers shall contain low VOC (Volatile Organic Compounds), as outlined in the South Coast Air Quality Management District (SCAQMD) Rule #1168.

1.04 REGULATORY REQUIREMENTS

- A. Conform to the most recent editions of the applicable City codes and ordinances and NFPA 54.
- B. Piping materials specified herein are acceptable products to the Architect, but all are not necessarily acceptable to applicable local codes and ordinances. It is the responsibility of the Contractor to provide materials, from the options listed herein, that are acceptable to both the Architect and applicable local codes and ordinances.

1.05 SUBMITTALS

- A. Submit product data on pipe materials, fittings, valves and accessories in accordance with Division 01 and Section 22 0010.
- B. Submit shop drawings and piping layout in accordance with Division 01 and Section 22 0010.
- C. Submit certificates as listed below to Architect in accordance with Division 01 and Section 22 0010.
 - 1. Test Certificates of Approval for Piping Systems.
 - 2. Flushing Certificates of Approval for Piping Systems.
 - 3. Disinfection Certificates of Approval for Domestic Water Piping Systems.

1.06 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

PART 2 - PRODUCTS

2.01 SANITARY WASTE AND VENT PIPING

- A. Sanitary waste and vent piping, below grade.
 - 1. Cast Iron Pipe & Fittings: ASTM A74 service weight. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
- B. Sanitary waste and vent piping, above grade.
 - 1. Cast Iron Pipe & Fittings: CISPI 301, hubless. Joints: ASTM C 564, neoprene gaskets and stainless steel clamp-and-shield assemblies. Joints shall be Heavy Duty couplings conforming to ASTM C 1540 as manufactured by Husky SD 4000 or Clamp All 125.

2. Copper Pipe: ASTM B306, DWV. Fittings; ANSI/ASME B16.3, cast bronze, or ANSI/ASME B16.29, wrought copper. Joints: ANSI/ASTM B23, solder, Grade 50B.

2.02 WATER PIPING

- A. Water piping buried within 5 ft. of building, and beneath slab.
 1. Copper Tubing: For 2-1/2 in. diameter and less, ASTM B88, Type "K" annealed. Fittings: ANSI/ASME B16.18, cast copper or ANSI/ASME B16.22, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 95TA.
- B. Water piping, above grade.
 1. Copper Tubing: For 4 in. diameter and less, ASTM B88, Type "L", hard drawn. Fittings: ANSI/ASME B16.18, cast brass, or ANSI/ASME B16.22, wrought copper. Joints: ANSI/ASTM B32, solder, Grade 95TA.
 2. Mechanically pressed copper fittings are acceptable for pipe sizes 1/2 in. through 4 in. diameter. Operating pressure: 200 PSI CWP Max, Temperature range: -20°F to 250°F. Fittings shall conform with ASME B16.18, ASME B16.22 or ASME B16.26, and performance criteria of IAPMO PS-117 or ASME B16.51. Fittings shall utilize a factory installed EPDM sealing element and be listed by NSF 61. The installer shall be trained and certified by the fitting manufacturer. Copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer. Acceptable products are Viega ProPress.
 - a. Per UNT Design and Construction Standards, use of mechanical joints for domestic water piping is preferred over soldered connections.

2.03 FLANGES, UNIONS AND COUPLINGS

- A. Pipe Size 2 in. and under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints. Bolt standard for flange connections is ASTM A193 grade B7: Alloy Steel, AISI 4140/4142.
- B. Pipe Size Over 2 in.: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; gaskets suitable for intended service – NO ASBESTOS GASKET MATERIAL ALLOWED. Bolt standard for flange connections is ASTM A193 grade B7: Alloy Steel, AISI 4140/4142.
- C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction and expansion; "C" shape composition sealing gasket; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.
 1. Acceptable Manufacturers:
 - a. Victaulic
 - b. Apollo Shurjoint

- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, and water impervious isolation barrier.

2.04 BALL VALVES

- A. Ball valves: For water shut-off and throttling.

1. Ball valves 2 in. and less: Rated 175 lb. minimum water, oil, air and gas pressure, bronze construction, seat material as recommended by manufacturer for material conveying, lever handle, threaded or soldered connections. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).

- a. Acceptable Manufacturers and Models:

- 1) Crane 9302, 9322
- 2) Apollo 70 Series
- 3) Jomar T-100-SS
- 4) ITT Grinnell 3500, 3500SJ
- 5) Milwaukee BA-200, BA-250
- 6) Watts B-6000, B-6001
- 7) Nibco T-580, & S-500
- 8) KITZ 868

2. Ball valves 2-1/2 in. and greater, 150 lb. minimum water, oil, air and gas pressure, bronze or carbon steel construction, seat material as recommended by manufacturer for material conveying, lever handle, flanged connections. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).

- a. Acceptable Manufacturers and Models:

- 1) Crane 941-TF
- 2) Jomar T-100-SS (NPT) or FL-CS-100-150
- 3) Apollo 88-100
- 4) Jamesbury D150F
- 5) KITZ 858 Threaded

2.05 CHECK VALVES

- A. Swing check valves: For water.

1. Check Valves 2 in. and less: MSS SP-80 rated 175 lb. minimum water and air pressure, bronze construction, renewable seat, bronze disc, threaded or soldered connections.

a. Acceptable Manufacturers and Models:

- | | |
|--------------|---------|
| 1) Nibco | T-413 |
| 2) Apollo | 163T |
| 3) Crane | 137 |
| 4) Jomar | T/S-511 |
| 5) Stockham | B-321 |
| 6) Milwaukee | 508 |
| 7) KITZ | 822 |

2. Check Valves 2-1/2 in. and greater: MSS SP-71 rated 150 lb. minimum water and air pressure, iron body, bronze mounted, flanged connections.

a. Acceptable Manufacturers and Models:

- | | |
|-----------------|--------|
| 1) Crane | 373 |
| 2) Apollo | 910F |
| 3) Nibco | F-918 |
| 4) Milwaukee | F-2974 |
| 5) ITT Grinnell | 6300A |
| 6) KITZ | 78 |

2.06 PIPING SPECIALTIES

- A. Provide piping specialties in accordance with Section 22 1119.

2.07 PLUMBING SUPPORTS AND ANCHORS

- A. Provide supports and anchors in accordance with Section 22 0529.

2.08 PLUMBING INSULATION

- A. Provide mechanical insulation in accordance with Section 22 0716.

2.09 PLUMBING IDENTIFICATION

- A. Provide mechanical identification of all piping systems and valves in accordance with Section 22 0553.

PART 3 - EXECUTION

3.01 PIPING

- 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. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- E. Route piping in orderly manner and maintain gradient.
- F. Install piping to conserve building space and not interfere with use of space.
- G. Pipes passing through concrete or cinder walls and floor or other corrosive material shall be protected by a protective sheathing or wrapping or by sleeves, as required to meet the local code. Annular spaces between sleeves and pipes shall be filled or tightly caulked in an approved manner. Annular spaces between sleeves and pipes in fire-resistance-rated assemblies shall be filled or tightly caulked in accordance with the local code.
- H. Group piping whenever practical at common elevations.
- I. Exposed piping, valves, fittings, escutcheons, trim, etc., serving plumbing fixtures in finished areas, shall be polished chromium plated. Exposed piping, valves, fittings, escutcheons, trim, etc., serving plumbing equipment, kitchen equipment, or other equipment located in finished areas, shall be chrome plated, or when not available with chrome plating, they shall be painted with chromium paint.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- K. Provide clearance for installation of insulation and access to valves and fittings.
- L. Provide access where valves and equipment are not accessible. Coordinate size and location of access doors with applicable Section.
- M. Slope water piping and arrange to drain at low points. Install manual type air vents at high points in system.
- N. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Division 09 - FINISHES
- O. Install piping parallel with or at right angles to walls unless otherwise shown on Drawings.
- P. Conceal piping above ceilings, in walls or chases etc., unless otherwise shown or noted on Drawings.
- Q. Joints in soft copper piping below slab will not be allowed.
- R. Soft copper shall not be routed through areas with exposed ceilings except in mechanical rooms.
- S. Bending of rigid piping is not permitted; only ells shall be utilized for a change in direction.
- T. Temporarily plug or cap open ends of pipe at the end of each workday.

- U. Establish invert elevations for drainage piping. Minimum slopes for drainage are 1/4 in. per foot for 3 in. diameter and less and 1/8 in. per ft. for 4 in. diameter pipe and greater.
- V. Install bell and spigot pipe with bell end upstream.
- W. Materials exposed within ducts or plenums (ceiling spaces used as supply or return air plenums) shall have a flame-spread index of not more than 25 and a smoke-developed rating of not more than 50 when tested in accordance with the test for Surface Burning Characteristics of Materials, U.B.C. Standard No. 42-1. Do not install any PVC piping in any Return Air Plenums.
- X. Fuel-gas lines and waste cleanouts shall not be located within an air supply plenum.
- Y. Piping hangers shall be sized large enough to allow insulation to pass through. Hangers for piping 2-1/2 in. and greater shall be provided with pipe covering protection saddle, or high compressive strength insulation saddle. Hangers for piping 2 in. and less shall be provided with pipe covering shields. On cold or chilled water piping provide vapor barrier through hanger.
- Z. Domestic water service piping below building shall be provided with both tie-rod and thrust block restraint in accordance with NFPA 24. Tie-rod restraint shall be provided vertically from the below floor elbow at the base of the riser out to the first hub beyond 5 ft. 0 in. from building. (See NFPA 24-1995 figure A-8-6.2 (b)). Thrust block restraint shall be provided on the below floor elbow at the base of the riser. Area of bearing face of concrete thrust block shall be 32 sq. ft.
- AA. Support vertical piping at every floor.

3.02 PIPING CONNECTIONS

A. Threaded Connections

1. Threaded joints shall be in accordance with ANSI B1.20.1. Threaded joints shall be made up Teflon tape or lead free pipe joint compound applied to the male thread only. Should a joint be loosened after being made up, it shall not be made up a second time unless the threads are cleaned and new compound applied.
2. All steel piping which is assembled with screwed joints shall have exposed threads thoroughly primed with a coat of lead free rust resistant paint. Paint immediately after installation. This shall apply to both piping that is to be covered as well as uncovered.

B. Soldered Connections

1. Soldered joints shall be in accordance with ASTM B32. Flux shall be nonacid type. Remove composition discs from solder end valves during soldering. Pipe ends, fittings and valves shall be properly cleaned before soldering and wiped clean to remove flux and excess solder after soldering.

C. Welded Connections

1. Welded joints shall be in accordance with AWS D10.12-79. The oxyacetylene or electric process shall make all joints.

2. Nipples or half couplings welded into the mains will not be accepted. Welded branch connections shall be used to tap mains only where the mains are at least two pipe sizes larger than the branch.
 3. All openings cut into pipe for welded outlets shall be accurately made, to give matched intersections. For welded branch outlet fittings, the opening shall be cut before the fittings welded.
 4. Long radius type ells shall be on all bends in welded pipelines. No field fabricated or factory segmentally fabricated fittings shall be allowed.
 5. Welds on piping shall be cleaned and primed with corrosion resistant paint before insulation is applied or installation is complete.
- D. Solvent Cement Connections:
1. Solvent cement connections shall be joined with primer and PVC solvent cement complying with ASTM D2564. Solvent cement connections shall be in compliance with GSR Bulletin SCJ-1 Solvent Cementing Procedure.
- E. Mechanical Grooved Connections:
1. Pipe shall be prepared and mechanical grooved connections shall be assembled in accordance with ANSI/AWWA C606 and the latest published instructions from the manufacturer.
- F. Copper Press Connections:
1. Mechanical copper press fittings shall be made in strict accordance with the manufacturer's installation instructions.
 - a. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

3.03 FLANGES AND UNIONS

- A. Provide flanges and unions at all final connections to equipment, and traps. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shut-off valves.
- B. All flanged connections shall be in accordance with ANSI B16.5 for steel flanges and ANSI B16.1 for cast iron flanges.
- C. Bolting shall be in accordance with ASTM A307 Grade B with bolts and nuts in accordance with ANSI B18.2.1 and ANSI B18.2.2.
- D. Tighten flange bolts in sequence 180° directly opposite each to equal tension.
- E. Flanges and unions shall be made of same material or compatible material as piping systems in which they are installed.

3.04 VALVES

- A. Install valves with stems upright or horizontal, not below horizontal. All valves shall be located with sufficient room for maintenance or replacements. Install unions to facilitate the removal of traps, valves, strainers, etc.
- B. Horizontal swing check valves shall be installed in a true horizontal position. Vertical lift check valves shall be installed in a true vertical position.
- C. Install ball valves for shut-off and to isolate equipment, parts of systems, or vertical risers. Provide shut-off valves at all pipe branches and where required to facilitate partial system isolation. All equipment, fixtures, or other appliances attached to any water piping system will have a shut-off valve located at the connection to the piping system.
- D. Install ball valves for throttling, bypass or manual flow control services.
- E. Throttling or balancing valves shall be provided with memory stops.

3.05 TESTING

- A. General: Furnish pumps, gauges, equipment and personnel required, and test as necessary to demonstrate the integrity of the finished installation.
- B. Soil, Waste and Vent, and Storm Drainage: Unless otherwise directed, plug all openings and fill with water to a height equal to the lowest vent or roof drain. Test at 10 foot of head pressure for no less than four hours. Remake leaking joints and retest.
- C. Water Lines: Hydrostatically test and make tight at 150 psi. Retain for four hours. Repair all leaking joints and retest. System shall have no more than 5 lb. of pressure loss. If more than 5 lb. of pressure loss, detailed written explanation and/or repairs are required per UNT Design and Construction Standards.
- D. Tests and test procedures shall be witnessed and approved by the Architect.
- E. After completion and approval of testing, submit "Test Certificates of Approval" for Sanitary Waste and Vent and Water piping systems stating that all test results are satisfactory. Certificates of approval must be signed by Contractor.

3.06 FLUSHING

- A. General: After piping systems have been tested and approved, systems shall be flushed. Furnish compressors, pumps, equipment, personnel, etc. required to flush piping systems.
- B. Water Lines: Flush piping with water until water flows clear for a minimum of 60 seconds per 100 linear ft. of piping being flushed at a velocity of 9 ft. per second.
- C. All strainers and filters shall be cleaned and replaced prior to start-up.
- D. Flushing and flushing procedures shall be witnessed and approved by the Architect.
- E. After completion and approval of flushing, submit "Flushing Certificates of Approval" for water piping systems stating that all flushing results are satisfactory. Certificates of approval must be signed by Contractor.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50-to 80 mg/L residual.
- C. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 5 remote outlets.
- D. Maintain disinfectant in system for 24 hours.
- E. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- F. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- G. Take samples no sooner than 24 hours after flushing, from 5 remote outlets and from water entry, and analyze in accordance with AWWA C651.
- H. Disinfection and disinfection procedures shall be witnessed and approved by the Architect.
- I. After disinfection is completed, submit "Disinfection Certificate of Approval" for domestic water piping systems to the Architect stating that all test results are satisfactory. Certificate of Approval must be signed by Contractor. Certificate shall show the date, time and residual of each of the following tests:
 - 1. Initial disinfection residual (50 PPM minimum) - 5 samples.
 - 2. Final disinfection residual (25 PPM minimum) - 5 samples.
 - 3. After flushing residual (5 PPM maximum) - 5 samples.
 - 4. Analyze in accordance AWWA C651 - 5 samples.

3.08 CLOSING IN UNINSPECTED WORK

- A. Do not cover up or enclose work until it has been properly and completely inspected and approved. Should any of the work be covered up or enclosed prior to all required inspections and approvals, uncover the work as required. After it has been completely inspected and approved, make all repairs and replacements as necessary to the satisfaction of the Architect, Engineer, and Owner's Representative. Repairs and replacements shall be at no additional cost to the Owner.

END OF SECTION

**SECTION 22 1001
PLUMBING SPECIALTIES**

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of Plumbing Specialties Work required by this section is indicated on Drawings and by requirements of this section.
- B. Types of Plumbing Specialties specified in this section include the following:
 - 1. Cleanouts.
 - 2. Water hammer arrestors.
 - 3. Trap guards.
 - 4. Thermostatic mixing valves.

1.02 REFERENCES

- A. ANSI A112.26.1 - Water Hammer Arresters.
- B. PDI WH-201 Water Hammer Arresters.
- C. NFPA 54 - National Fuel Gas Code, latest edition.

1.03 QUALITY ASSURANCE

- A. Conformance with applicable state and local codes and ordinances.
- B. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- C. Plumbing Certification: Persons performing plumbing work shall have a current Texas State Plumbing License.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable City codes and ordinances and NFPA 54.

1.05 SUBMITTALS

- A. Submit product data in accordance with Division 01 and Section 23 0010.
- B. Include component sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.01 CLEANOUTS

- A. Floor Clean out: Cast iron body, adjustable type, inside caulk connection, vandal proof secured standard round nickel bronze top, threaded bronze plug.

1. Acceptable Manufacturers and Models:
 - a. Josam Series 56000-X-22-15
 - b. Smith Series 4028C-U
 - c. Tyler/Wade Series W-6000-IC-5
 - d. Zurn Series ZN-1400IC-BP-VP
 - e. Mifab Series C1100X-R
 - f. Watts Series CO-100-C-RX
- B. Floor Clean out: Cast iron body, adjustable type, inside caulk connection, vandal proof heavy-duty tractor type round nickel bronze top, threaded bronze plug.
 1. Acceptable Manufacturers and Models:
 - a. Josam Series 56040-1-22-15
 - b. Smith Series 4108C-U
 - c. Tyler/Wade Series W-6000-IC-5
 - d. Zurn Series ZN-1400IC-BP-HD-VP
 - e. Mifab Series C1100X-R
 - f. Watts Series CO-200-RX
- C. Floor Clean out: Provide special carpet clean out cover with clean out marker in all carpeted areas and special recessed cover which will allow for the same flooring material to be installed in clean out top in all areas with ceramic, quarry, and vinyl flooring material. Recessed cover shall be designed for type of flooring.
- D. Wall Clean out: Recessed wall type, cast iron body with threaded bronze plug, flush mounted stainless steel access cover with countersunk center screw and vandal proof secured.
 1. Acceptable Manufacturer and Models:
 - a. Josam Series 58710-15
 - b. Smith Series 4422C-U
 - c. Zurn Series Z-1441-BP-VP
 - d. Mifab Series C1450
 - e. Watts Series CO-450
- E. Wall Clean out: Cast iron clean out tee type with countersunk tapered threaded bronze plug. Provide "T" handle wrench.

1. Acceptable Manufacturers and Models:
 - a. Josam Series 58910
 - b. Smith Series 4512S
 - c. Zurn Series Z-1445-BP
 - d. Mifab Series C1460
 - e. Watts Series CO-460

F. Wall Clean out: Cast iron clean out tee type with countersunk tapered threaded bronze plug, and stainless steel round access cover with countersunk center screw and vandal proof secured. Provide "T" handle wrench.

1. Acceptable Manufacturers and Models:
 - a. Josam Series 58790-15
 - b. Smith Series 4532S-U
 - c. Zurn Series Z-1446-BP-VP
 - d. Mifab Series C1460-RD
 - e. Watts Series CO-460-RD

2.02 WATER HAMMER ARRESTORS

A. Water Hammer Arrestors (WHA): ANSI A112.26.1, ASSE 1010, and PDI WH-201; permanently sealed expanding chamber type . Sizing symbols indicated on Drawings refer to Plumbing and Drainage Institute "Standard PDI-WH201" established standard classifications. Air chambers are not allowed.

1. Acceptable Manufacturers and Models:
 - a. Expanding Chamber Type
 - 1) PPP "SC" Series
 - 2) Sioux Chief "Hydra-Rester" Series
 - 3) Watts Series 15
 - 4) Mifab CL/MWH

2.03 TRAP GUARDS

A. Trap Guard shall be an elastomeric, normally closed trap guard device that utilizes a normally closed seal to prevent evaporation of the trap seal and also protect against sewer gases from backing up into habitable areas. It shall open with fluid and allow liquid drainage to flow through into the building drain. The elastomeric membrane material shall be tested according to CAN/CSA B602 Standard requirements.

1. Acceptable Manufacturers and Models:
 - a. ProVent Systems ProSet Trap Guard
 - b. Sure Seal SS3509
 - c. No Substitutions

2.04 THERMOSTATIC MIXING VALVES

- A. Thermostatic Mixing Valve Station: Thermostatic type to automatically close hot water port if cold-water pressure fails or close cold-water port if hot water pressure fails, and closes both ports if thermostatic element fails. Valve shall include check valves, stops, and strainers. See Schedule for capacity. Mixing valve shall be installed in a surface mounted or a recessed stainless steel cabinet.

1. Acceptable Manufacturers and Models:
 - a. Powers 430
 - b. Leonard TM
 - c. Symmons 5-A Series

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate cutting or forming of floor construction to receive drains to required invert elevations.

3.02 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded clean out plugs with mixture of graphite and linseed oil. Ensure clearance at clean out for rodding of drainage system.
- C. Trap all drains connected to the sanitary sewer.
- D. Install floor and area drains with top depressed 1/2 in. below finished floor elevation.
- E. In addition to cleanouts, as shown on the Drawings, Contractor shall provide any additional cleanouts required by local codes and ordinances at no additional cost to the Owner.
- F. Install trap guards on all floor drains unless specifically not required by local codes.

END OF SECTION

**SECTION 22 1119
PIPING SPECIALTIES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of piping specialties work required by this section is indicated on Drawings and schedules and by requirements of this section.
- B. Types of piping specialties specified in this section include the following:
 - 1. Pipe Escutcheons.
 - 2. Dielectric Unions.
 - 3. Mechanical Penetration Seals.
 - 4. Fire Barrier Penetration Seals.
 - 5. Pipe Sleeves.
 - 6. Penetration Seals.
- C. Piping specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned Drawings for each type of manufactured piping specialty. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
- B. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop Drawings in maintenance manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 PIPING SPECIALTIES

- A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

2.02 PIPE ESCUTCHEONS

- A. General: Provide pipe escutcheons as specified herein with inside diameter tightly fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas: Exterior use and interior use including mechanical rooms and any room with water or floor type drains. For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.
- D. Manufacturer: Subject to compliance with requirements, provide pipe escutcheons of one of the following or approved equal:
 - 1. Chicago Specialty Mfg. Co.
 - 2. Producers Specialty & Mfg. Corp.
 - 3. Sanitary-Dash Mfg. Co.

2.03 DIELECTRIC UNIONS

- A. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
- B. Manufacturer: Subject to compliance with requirements, provide dielectric unions of one of the following or approved equal:
 - 1. B & K Industries, Inc.
 - 2. Capital Mfg. Co.; Div. of Harsco Corp.
 - 3. Eclipse, Inc.
 - 4. Epco Sales, Inc.
 - 5. Perfection Corp.

6. Rockford-Eclipse Div.

2.04 PENETRATION SEALS

- A. Caulked Seals: Provide seals for penetrations through interior walls of one of the following:
1. Mineral Wool or Oakum: Caulked watertight between sleeve and pipe.
- B. Mechanical Seals:
1. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
 2. Manufacturer: Subject to compliance with requirements, provide mechanical sleeve seals of one of the following or approved equal.
 - a. Thunderline Corp.
- C. Fire Barrier Seals:
1. Provide seals for any opening through smoke or fire-rated walls, and all above grade floors, used as passage for mechanical components such as piping or ductwork.
 2. Cracks, Voids, or Holes Up to 4 in. Diameter: Use putty or caulking, one-piece intumescent elastomer, non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat, UL-listed.
 3. Openings 4 in. or Greater: Use sealing system capable of passing 3-hour fire test in accordance with ASTM E-814, consisting of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350°F UL-listed.
 4. Manufacturer: Subject to compliance with requirements, provide fire barrier penetration seals of one of the following or approved equal.
 - a. 3M Fire Barrier Sealant CP25WB+
 - b. Hilti FS One Max Firestop Intumescent
 - c. Any other manufacturers shall be reviewed and approved by AHJ

2.05 PIPE SLEEVES

- A. Provide pipe sleeves of one of the following:
1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3 in. and smaller, 20 gauge; 4 in. to 6 in. 16 gauge; over 6 in., 14 gauge.
 2. Steel-Pipe: Fabricate from Schedule 10 (minimum) steel pipe; remove burrs.
 3. Floor sleeves shall be provided with water stop around perimeter of sleeve.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.
- C. Mechanical Penetration Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.
- D. Fire Barrier Penetration Seals: Fill opening with sealing compound. Adhere to manufacturer's installation instructions.
- E. Drip Pans: Locate drip pans under piping passing over or within 3 ft. horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1 in. drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.
- F. Pipe Penetrations: Sleeve new construction or core drill existing construction pipe penetrations as specified below where piping passes through walls, floors, and roofs. Do not penetrate structural members, except as detailed on Drawings, or as reviewed by Architect. Install penetrations accurately centered on pipe runs. Size penetrations so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than two pipe sizes larger than piping run. Where insulation includes vapor-barrier jacket, provide penetration with sufficient clearance for installation. When sleeves are required, install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves two inches above finished floor. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeve. All pipe penetrations shall be individual pipes or conduits. Groups of pipes or conduits in a common penetration is not allowed. Pipe penetrations shall be as follows:
 - 1. Existing Floors Above Grade: Provide core-drilled penetrations for all piping.
 - 2. New and Existing Walls: Provide sleeved or core drilled penetrations for all piping.
 - 3. Floor type drains, cleanouts, and water closet waste connections do not require sleeved or core drilled penetrations. Concrete shall be placed tight to connection.
- G. Pipe Sleeves: Install in accordance with the following:
 - 1. Install sheet metal on steel pipe sleeves in interior walls.
 - 2. Install steel pipe sleeves in interior floors above grade.

3. Install galvanized steel pipe sleeves in floors on grade and in exterior walls above grade and below grade.

H. Penetration Seals:

1. Install mineral wool/oakum seals as follows:
 - a. In interior walls where piping passes from one space to another, where any one of the spaces the piping penetration is not concealed by a ceiling. Caulk penetration watertight.
2. Install mechanical seals in accordance with manufacturer's recommendations as follows:
 - a. In interior floors on grade.
 - b. In interior floors above grade, use three-hour fire rated type only.
3. Install fire barrier seals in accordance with manufacturer's recommendations as follows:
 - a. In all floors above grade and fire rated walls.

END OF SECTION

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**SECTION 22 3000
PLUMBING EQUIPMENT**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of Plumbing Equipment Work required by this section is indicated on Drawings and Schedules, and by requirements of this section.
- B. Types of Plumbing Equipment specified in this section include the following:
 - 1. Domestic water heaters and accessories.
 - 2. Domestic hot water circulation pump.

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code, latest edition.
- B. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water heaters.

1.03 QUALITY ASSURANCE

- A. Plumbing Certification: Persons performing plumbing work shall have a current State Plumbing license.
- 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 Electrical Manufacturers' Association (NEMA).
 - 2. Underwriters Laboratories (UL).

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable City codes and ordinances.
- B. Conform to UL requirements for water heaters.

1.05 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Division 01 and Section 22 0010.
- B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
- C. Include heat exchanger dimensions, size of tappings, and performance data.
- D. Submit manufacturer's installation instructions of all equipment and accessories in accordance with Division 01 and Section 22 0010.

- E. Submit certificates as listed below to Architect in accordance with Division 01 and Section 22 0010.
 - 1. Test Certificates of Approval for plumbing equipment.
 - 2. Demonstration Certificates of Completion for all plumbing equipment.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data in accordance with Division 01 and Section 22 0010.
- B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- C. Include operation, maintenance, and inspection requirements as required by the Department of Labor and Standards, Boiler Division.

1.07 WARRANTY

- A. Provide five year manufacturer's non-prorated warranty for domestic water heaters in accordance with Division 01 and Section 22 0010.

PART 2 - PRODUCTS

2.01 DOMESTIC WATER HEATERS AND ACCESSORIES

- A. Electric Water Heaters (Direct Fired)
 - 1. Domestic water heater: ASHRAE 90.1-2022 energy efficient, standard or lowboy height electric vertical type, interior-lined tank, anode protection, drain valve, safety relief valve, high-temperature cut-off, individual operating thermostats, insulated tank, baked enamel exterior steel jacket, and UL approved.
 - a. Acceptable Manufacturers and Models:
 - 1) State
 - 2) AO Smith
 - 3) Rheem
 - 4) Lochinvar
 - 5) Bradford White

2.02 WATER HEATING SYSTEM ACCESSORIES:

- A. Circulation pumps: Inline type, flanged connections, rated for 125 psi at 220°F, single stage, vertical split case, all bronze or stainless steel and provided with oil cups. See Schedule for capacity. Provide with integral timer for IECC compliance.
 - 1. Acceptable Manufacturers:
 - a. Bell & Gossett

- b. Armstrong
 - c. Taco
 - d. Grundfos
- B. Thermostatic control for circulation pumps: Heavy-duty snap-acting SPDT switch, copper constructed liquid filled capillary and bulb sensing element, 100 to 210°F set point adjustment range, 5 to 15°F adjustable differential, 120 VAC, UL listed.
- 1. Acceptable Manufacturer and Model:
 - a. Barber-Colman Company TC-4112
- C. Expansion Tank for Water Heater: Bladder type, full acceptance, fabricated steel shell constructed and stamped per ASME VIII, heavy duty butyl FDA approved removable bladder, 125 psig working pressure, 240°F operating temperature. Tank head shall be galvanized. Pre-charge tank to static pressure of system.
- 1. Acceptable Manufacturer and Model:
 - a. Elbi DTS Series
 - b. Amtrol STC Series
 - c. Watts DETA Series
 - d. Taco CA Series

2.03 PIPING SPECIALTIES

- A. Provide piping specialties in accordance with Section 22 1119.

2.04 PLUMBING SUPPORTS AND ANCHORS

- A. Provide supports and anchors in accordance with Section 22 0529.

2.05 PLUMBING METERS AND GAUGES

- A. Provide meters and gauges in accordance with Section 22 0519.

2.06 PLUMBING INSULATION

- A. Provide mechanical insulation in accordance with Section 22 0716.

2.07 PLUMBING IDENTIFICATION

- A. Provide mechanical identification of all equipment in accordance with Section 22 0553.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment and accessories in accordance with manufacturer's recommendations.
- B. Coordinate with electrical work to achieve operational system.
- C. Provide all interconnecting electrical power and control wiring from control panel to equipment and accessories for a complete operable system. All exposed wiring shall be in conduit.
- D. Coordinate exact location of water heater to insure all required clearances are maintained.

3.02 TESTING

- A. Contractor and Manufacturer's Representative shall test water heaters including all associated accessories and controls to ensure proper operation.
- B. Contractor shall test water heaters including all associated accessories and controls to ensure proper operation.
- C. Tests shall be witnessed and approved by the Architect.
- D. After completion and approval of testing, submit "Test Certificate of Approval" for water heaters including all associated accessories and controls stating that all test results are satisfactory. Certificates of Approval must be signed by the Contractor.

3.03 DEMONSTRATION OF EQUIPMENT

- A. Prior to final acceptance, Contractor and Manufacturer's Representative of Domestic Water Heaters and associated accessories and controls, each shall provide a minimum of 4 hours (or as long as required by the Owner) to demonstrate to the Owner the proper operation of the equipment.
- B. Prior to final acceptance, Contractor shall provide a minimum of 4 hours (or as long as required by the Owner) to demonstrate to the Owner the proper operation of all the plumbing equipment and associated accessories and controls installed under this section other than the equipment listed above.
- C. After completion and approval of demonstrations, submit "Demonstration Certificate of Completion" for domestic water heaters including all associated accessories and controls stating that the demonstration of all equipment is satisfactory. Certificates must be signed by the Manufacturer's Representative and Contractor.

END OF SECTION

**SECTION 22 4001
PLUMBING FIXTURES (SHORT FORM)**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Divisions 00 and 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Extent of Plumbing Fixture Work required by this section is indicated on Drawings and Schedules, and by requirements of this section.
- B. Types of plumbing fixtures specified in this section include the following:
 - 1. Water closets.
 - 2. Urinals.
 - 3. Lavatories.
 - 4. Stainless Sinks.
 - 5. Electric Water Coolers (Stainless Steel Cabinets).
 - 6. Flush Valves.
 - 7. Plumbing Brass.
 - 8. Sensor Operated Valves & Faucets.
 - 9. Floor Mounted Fixture Carriers.

1.03 REFERENCES

- A. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- B. ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
- C. ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- D. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
- E. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- F. All fixtures shall comply with ANSI/NSF STD 61.

1.04 QUALITY ASSURANCE

- A. Conformance with applicable state and local codes and ordinances.
- B. Fixtures: By same manufacturer throughout.

- C. Trim: By same manufacturer throughout.

1.05 REGULATORY REQUIREMENTS

- A. Conform to the most recent editions of the City codes and ordinances.
- B. Conform to Article 7/601b. - Vernon's Texas Civil Statutes (Handicapped Accessibility Act) (Texas Accessibility Standards (TAS)).

1.06 SUBMITTALS

- A. Submit product data in accordance with Division 01 and Section 22 0010.
- B. Include fixtures, sizes, utility sizes, trim, and finishes.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data in accordance with Division 01 and Section 22 0010.
- B. Include fixture trim exploded view and replacement parts lists.

1.08 WARRANTY

- A. Provide one-year manufacturer's warranty for electric water cooler compressor in accordance with Division 01 and Section 22 0010.

PART 2 - PRODUCTS

2.01 PLUMBING FIXTURES

- A. Provide plumbing fixtures as scheduled or approved equal.
- B. Approved equals will be limited to the following manufacturers:
 - 1. Water Closets:
 - a. American Standard.
 - b. Kohler.
 - 2. Urinals:
 - a. American Standard.
 - b. Kohler.
 - 3. Lavatories:
 - a. American Standard.
 - b. Kohler.
 - 4. Stainless Steel Sinks:
 - a. Elkay.

- b. Just.
- 5. Electric Water Coolers (Stainless Steel Cabinet):
 - a. Halsey Taylor.
- 6. Plumbing Brass:
 - a. Chicago Faucets.
 - b. T & S Brass.
- 7. Sensor Operated Flush Valves & Faucets:
 - a. Sloan.
- 8. Floor Mounted Fixture Carriers:
 - a. Josam.
 - b. Smith.
 - c. Watts
 - d. Zurn.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
- B. Verify adjacent construction is ready to receive rough-in work of this Section.

3.02 INSTALLATION

- A. Install each fixture in accordance with the manufacturer's recommendations.
- B. Piping, valves, fittings, trim, etc. shall be polished chromium plated when exposed in finished areas.
- C. Piping penetrating floors, walls or ceilings shall be provided with solid polished chromium plated escutcheons.
- D. Install components level, plumb, and at right angles to walls.
- E. Provide floor mounted carriers for all wall mounted fixtures.
- F. Install and secure fixtures in place with wall supports carriers and bolts. Exposed bolts, nuts, etc. shall be stainless steel or chrome-plated brass.
- G. Seal fixtures to wall and floor surfaces with white sealant.

- H. Mount fixtures to Architectural drawings interior wall elevations and to requirements of ADA and TAS.
- I. Provide removable insulation covering on stops and supplies and drains and P-traps on all handicapped lavatories with hot water supply. All lavatories in rooms with handicapped water closets are considered handicapped lavatories.
- J. Provide keyed stops on all water supplies to fixtures and equipment.
- K. Provide water hammer arrestors on hot and cold water supplies to all plumbing fixtures. Water hammer arrestors shall be as shown on diagrams and if not shown, provide for each fixtures in accordance with Standard PDI-WH-201.
- L. Provide drainage and vent piping run outs to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the Plumbing Code.
- M. Provide drainage piping run outs to urinals of cast iron material. Copper or brass material is not allowed.
- N. Provide all sensor operated faucets with manufacturer's optional ASSE 1070 below-deck thermostatic mixing valve.
- O. Provide all sensor operated flush valves with manual override function.

3.03 ADJUSTING AND CLEANING

- A. Adjust and balance stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. At completion clean plumbing fixtures and equipment.

END OF SECTION

**SECTION 23 0010
BASIC MECHANICAL REQUIREMENTS**

PART 1 - GENERAL

1.01 GENERAL PROVISIONS AND SUPPLEMENTAL GENERAL PROVISIONS

- A. The "General Conditions" and "Supplementary Conditions" are by reference made a part of this section and shall apply to each and every heading as though included herein.
- B. In the event of conflict, the requirements of the "General Conditions" and "Supplementary Conditions" will take precedence over these "General Requirements".

1.02 GENERAL

- A. The Contractor shall provide all plans, labor, equipment, appliances and materials, and shall perform all operations in connection with the installation of the mechanical work in accordance with the Specifications, applicable drawings, and the conditions specified above.
- B. Contractor shall provide all equipment required and usually furnished in connection with such work and systems whether or not specifically mentioned or specifically indicated on the drawings.

1.03 COMMISSIONING

- A. The Contractor shall provide all system commissioning services as required by section C408 of the applicable edition of the International Energy Conservation Code (IECC). Mechanical systems shall comply with IECC section C403.
- B. Commissioning, as outlined in IECC section C408 shall include the following:
 - 1. A commissioning plan.
 - 2. Air systems balancing.
 - 3. Hydronic systems balancing.
 - 4. Functional performance testing for all mechanical equipment, controls and economizers.
 - 5. A preliminary commissioning report.
 - 6. Final documentation including drawings, O&M manual(s), T&B report, and final commissioning report.
- C. Per the 2018 IECC the Mechanical System and Service Hot Water System Commissioning is not required when cooling equipment capacity is less than 480,000 Btuh (40 Tons) and the combined Space Heating and Service Hot Water System heating capacity is less than 600,000 Btuh (50 Tons).

1.04 INSPECTION OF THE SITE

- A. The Contractor shall visit the site, verifying all existing items indicated on drawings and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil conditions, and local requirements. The submission of bids shall be deemed evidence of such visits.
- B. All proposals shall take these existing conditions into consideration, and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.
- C. In the event that equipment specified and/or reviewed is not compatible with the existing conditions, the trade furnishing the equipment shall be responsible for notifying the Contractor prior to ordering it.

1.05 PERMITS, UTILITY CONNECTIONS, AND INSPECTIONS

- A. Refer to other sections of the specifications for construction phasing and time increments.
- B. The Contractor shall obtain and pay for all required utility connections, utility extensions and/or relocations and shall pay all costs and inspection fees for all work included herein.

1.06 APPLICABLE CODES AND STANDARDS

- A. 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 the Specifications, except as may be hereinafter modified in these Specifications and associated drawings.
- B. Latest edition of the National Fire Protection Association Standards (NFPA):
 - 1. NFPA No. 70 National Electrical Code
 - 2. NFPA No. 90A Installation of Air Conditioning and Ventilating systems
 - 3. NFPA No. 91 Exhaust systems of Air Conveying of Gases, etc.
 - 4. NFPA No. 96 Ventilation control and Fire Protection of Commercial Cooking Operations
 - 5. NFPA No. 101 Safety to Life from Fire in Buildings and Structures
 - 6. NFPA No. 255 Test of Surface Burning Characteristics of Building Materials
- C. United States of America Standards Institute (ASA) Standards:
 - 1. A40.8 National Plumbing Code
 - 2. B31.1 & B31.1a Code for Pressure Piping
- D. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes.
- E. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.

- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) 1985: All applicable manuals and standards.
- G. Air Moving and Conditioning Association (AMCA): All applicable manuals and standards.
- H. American Society of Testing and Material (ASTM): All applicable manuals and standards.
- I. American Water Works Association (AWWA): All applicable manuals and standards.
- J. National Electrical Manufacturer's Association (NEMA): All applicable manuals and standards.
- K. City Fire Department as applicable to construction of this site.
- L. City and State Building Codes.
- M. State of (Texas) Occupational Safety Act: Applicable safety standards.
- N. Occupational Safety and Health Act (OSHA).
- O. State of (Texas) Energy Conservation Construction Code.
- P. All work shall be in accordance with all regulations and requirements of the State of Texas Architectural Barriers Act (TAS).
- Q. Refer to Specifications sections hereinafter bound for additional codes and standards.
- R. All materials and workmanship shall comply with all applicable state and national codes, specifications, and industry standards. All material shall be listed by the Underwriter's Laboratories, Inc., as conforming to its standards and so labeled in every case where such a standard has been established for the particular type of material in question.
- S. All equipment provided and all installation methods shall meet all applicable requirements of the International Energy Conservation Code.
- T. 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 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 other specifications of the Contract Documents, providing no work or fabrication of materials has been accomplished in a manner of non-compliance. 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.

1.07 CONTRACT DOCUMENTS

- A. These specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, switch controls, circuits, lines, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.

- B. If the Contractor deems any departures from the drawings necessary, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior written acceptance.
- C. There are intricacies of construction that are impractical to specify or indicate in detail; however, in such cases the current rules of good practice and applicable specifications shall govern.
- D. It is the Contractor's responsibility to properly use all information found on the Civil, Architectural, Structural, Mechanical, Plumbing, Fire Protection, and Electrical drawings where such information affects his work.
- E. All dimensional information related to new structures should 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.
- F. The interrelation of the specifications, the drawings, and the schedules is 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.
- G. Should the drawings or specifications disagree within themselves, or with each other, the better quality of greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Architect in writing, shall be performed or furnished. Figures indicated on drawings govern scale measurements and large-scale details govern small-scale drawings.

1.08 SPACE AND EQUIPMENT ARRANGEMENT

- A. The size of fire protection, plumbing, mechanical, and electrical 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. Shop drawings shall be prepared 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.
- C. Maintain all code required clearances for equipment access.

1.09 FABRICATION DRAWINGS

- A. Contractor shall submit shop 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, and (3) where called for elsewhere in these specifications.
- B. Contractor shall submit ductwork fabrication and hydronic piping shop drawings for review by the Architect. Fabrication drawings shall be fully coordinated with ALL other trades and with existing conditions.
- C. All required shop drawings, except as hereinafter specified, shall be prepared at a scale of not less than 1/8 in. equal to 1 ft. for floor plans and 1/4 in. equal to 1 ft. for mechanical rooms.

1.10 SUPERVISION

- A. Each contractor shall keep a competent superintendent or foreman on the job at all times necessary for the timely and proper completion of the work.
- 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 this work with other trades, and before material is fabricated or installed, make sure that his work will not cause an interference that cannot be resolved without major changes to the drawings. If a conflict between trades arises that cannot be resolved at the jobsite, the matter shall be referred to the Architect for his ruling.

1.11 EXISTING FACILITIES

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, 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, and remove all such temporary protection upon completion of the work. All barricades and safety devices shall be in compliance with OSHA.
- 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 same 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, 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 control system devices, electrical switches, relays, fixtures, piping, conduit, etc.
- E. Outages of services, as required by the new installation, will be permitted only at a time approved by the Architect.

1.12 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. 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.

- 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 workmen skilled in the work and in accordance with standard practice of the trades involved.
- C. 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 and sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Architect. 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 of facilities, which must remain in operation during the construction period, shall not be interrupted without prior specific approval of the Architect as hereinbefore specified.
- D. All equipment and materials indicated to be removed and not be re-used shall be disposed of by the Contractor or salvaged as noted. For any items that are noted to be salvaged, Contractor shall Coordinate with Owner where materials are to be stored.

1.13 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall prepare, in triplicate for the Owner's Manual, complete sets of operating and maintenance instructions, system piping, valving, control and interlock diagrams, manuals, parts lists, etc., for each item of equipment. Include copies of all equipment warranties.
- B. In addition, the Contractor shall provide the services of a competent engineer or a technician acceptable to the Architect to instruct a representative of the Owner in the complete and detailed operation of all equipment and systems. These instructions shall be provided for a period of not less than 4 hours to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, stating the dates of instruction and the personnel to whom instructions were given. The Contractor shall be responsible for proper maintenance until the instructions have been given to the Owner's maintenance personnel.

1.14 GUARANTEE

- A. All work and equipment shall be guaranteed for a period of one year from the date of substantial completion.
- B. Guarantee shall be for all labor and materials.
- C. Certain items for equipment shall have additional or extended warranties when so specified.

1.15 MATERIALS AND WORKMANSHIP

- A. All materials, unless otherwise specified, shall be of current U.S. manufacture, new, free from all defects, 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 present a neat, workmanlike 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 furnishing the proper equipment and/or material, and to see 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.

1.16 FLAME SPREAD PROPERTIES OF MATERIALS

- A. Materials and adhesives incorporated in this project shall conform to NFPA 255, latest edition. The classification shall not exceed No. 2, with the range of indices between 0 to 25 for these Classifications as listed in the Federal Specifications. Modifications shall be made to insulating materials, etc., as required to comply with the Federal Specification.

1.17 LARGE APPARATUS

- A. Any large piece of apparatus which is to be installed in any space in the building, and which 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.

1.18 FLOOR AND CEILING PLATES

- A. Except as otherwise noted, provide chrome plated brass floor and ceiling plates around all pipes, conduits, ducts, etc., passing exposed through walls, floors, or ceilings, in any spaces, except under floor and attic spaces. 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. Plates will not be required for piping where pipe sleeves extend 3/4 in. above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have plates made to fit accurately at all floor, wall and ceiling penetrations.

1.19 SLEEVES, INSERTS AND FASTENINGS

- A. Proper openings through floors, walls, roofs, etc., for the passage of piping, ductwork, etc., shall be provided. All penetrations must pass through sleeves except soil pipe installed under concrete slabs on fill. 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.
- B. Pipes passing through concrete or cinder walls and floor or other corrosive material shall be protected by a protective sheathing or wrapping or by sleeves, as required to meet the local code. Annular spaces between sleeves and pipes shall be filled or tightly caulked in an approved manner. Annular spaces between sleeves and pipes in fire-resistance-rated assemblies shall be filled or tightly caulked in accordance with the local code.
- C. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeves shall be 1/4 in., except that the minimum clearance shall be 2 in. where piping contacts the ground. Sleeves through walls and partitions shall be installed flush with exposed surfaces. Sleeves through floors shall be extended 2 in. above finished floor.

- D. Above grade and dry location sleeves shall be constructed from 20 to 22 gauge galvanized steel. Sleeves passing through walls or floors on or below grade and/or moist areas such as mechanical rooms shall be constructed of galvanized steel Schedule 40 pipe and shall be designed with suitable flange in the center of the floor or wall to form a waterproof passage. After the pipes have been installed in the sleeves, void space around the pipe shall be sealed with "Link-Seal" modular wall and casing seals as manufactured by Thunderline Corporation.
- E. 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.
- F. Fastening of pipes, conduits, etc., in the building shall be as follows: To wood members - by wood screws; to masonry - by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are acceptable for general use, and will only be permitted where specifically acceptable to the Architect.
- G. Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.
- H. Vermin Proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be sealed with a continuous bead of sealant.
- I. The space around piping, ductwork, etc., penetrating walls, ceilings and floors that define air plenums shall be sealed airtight in an acceptable manner. Ceiling plenums used for return air are considered air plenums.

1.20 ACCESS DOORS

- A. This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed shutoff or service valves, strainer, unions, pressure reducing valves, trap primers, water hammer arrestors, heat trace cable junction boxes, and other items of concealed mechanical equipment. All access door locations are not shown on the drawings. It is the Contractor's responsibility to provide access doors at all locations required. Ensure alignment of access panels with valves/components to pipe chases and valves above ceilings or otherwise concealed. Under rooms which have reasonable possibilities of water in them, such as restrooms with floor drains, provide access panels in plaster or gypsum board ceilings. Access panels shall not require a special tool to unlock. Provide access to manifolds with integral factory or field-installed valves. Provide enough access to all full-open valves and shutoff valves.
- B. Access doors mounted in painted surfaces shall be equal to 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 surfaces of the adjacent finishes. Access doors mounted on tile surfaces shall be stainless steel materials. Access doors shall be minimum of 24 in. x 24 in. in size, where possible, to comply with UNT Design and Construction Standards.

1.21 CONSTRUCTION REQUIREMENTS

- A. The Architectural, Structural, Fire Protection, Mechanical, Plumbing, and Electrical plans and specifications including the General Provisions, Supplemental General Provisions, and other pertinent documents issued by the Architect, are a part of these specifications and the accompanying mechanical drawings, and shall be complied with in every respect. All the above is included in the Contract Documents, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of architectural, structural and electrical details from the mechanical drawings.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.
- C. 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 supplied by the manufacturer of the equipment to be installed and thereby to provide an integrated satisfactory operating installation.
- D. The mechanical and associated drawings are necessarily diagrammatic in character and cannot show every connection in detail or every pipe or equipment in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate pipe hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- E. When the mechanical drawings do not give exact details as to the elevation of pipe, ducts, etc., physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner, and the plans do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas. Piping specified to be insulated shall be supported in a manner that will allow the insulation to be installed without gaps. Insulated piping in concealed areas shall be offset with fittings as necessary to permit installation of insulation. Bending of pipes or installing pipes in a strain in order to insulate will not be permitted.
- F. All oiling devices and all parts of equipment requiring adjustment shall be easily accessible. Equipment shall be so located and installed as to permit convenient and safe maintenance and future replacement. Piping, ductwork, valve stems, etc., shall not block service space.

1.22 MECHANICAL SUBMITTALS AND SHOP DRAWINGS

- A. Definitions:
 - 1. Submittal - Equipment, Product Data, and Material Information for components proposed to be installed for the project.
 - 2. Shop Drawing - Scaled floor plans, riser or isometric diagrams, and elevations of proposed components to be installed for the project.
- B. Refer to the Conditions of the Contract (General and Supplementary) and Division 01 Section: "SUBMITTALS" for submittal definitions, requirements, and procedures.
- C. Submittals and Shop Drawings will be accepted only when submitted by the Contractor. Data submitted from Subcontractors and material suppliers directly to the Architect will not be processed.
- D. Submit Submittals, product data, and samples on items indicated in the individual sections.
- E. Submittals and Shop Drawings data shall not be used as requests or proposals for alternate equipment or materials. Refer to Item "Product Options and Substitutions" elsewhere in this section.
- F. THIRD PARTY CERTIFICATION: All Packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70, National Electric Code (NEC), Article 90-7.

1.23 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the Division 01 Section "SUBSTITUTION PROCEDURES" for requirements in selecting products and requesting substitutions.
- B. Standards for Materials:
 - 1. These specifications indicate a standard for all materials incorporated into the work, with manufacturer's names and catalog numbers used to establish a grade and quality of materials and equipment. The manufacturer listed on the equipment schedules, or named first in the specifications, is the one on whose equipment the layout is based. Other named manufacturers must meet the indicated performance and space requirements.
 - 2. The "approved equal" clause used in these specifications is to permit the proposal of unnamed manufacturer's products for the work, and the Architect decision concerning equal products is final.
 - 3. Considerations as to determination of equal products include, but are not limited to, the following:

Materials	Physical size
Workmanship	Weight
Gauges of Materials	Appearance
Available Local Service Personnel	Performance

Previous successful installations	Capacity
Delivery Schedules	Required Equipment Clearances

4. Shop Drawings must be submitted if proposed equipment differs in physical size than specified equipment to indicate proposed equipment has been coordinated with other trades and space allocated for this equipment. Shop Drawings must be at a 1/4" per foot scale indicating proposed equipment layout and any other equipment/materials noted in that general area. Other equipment may include, but is not limited to, HVAC equipment, plumbing equipment, electrical equipment, light fixtures, structural membersm cabinetry, etc.
 5. Failure to submit scaled Shop Drawings will indicate that the Contractor has coordinated their efforts with other trades and finds no conflicts with the work presented in the Contract Documents.
- C. Requests for substitutions for equipment, materials and apparatus listed in Division 23 Sections must be submitted in writing a **MINIMUM OF 10 DAYS** prior to the scheduled bid date. Such requests must be accompanied by complete data to permit proper evaluation.
- D. BIDS SHALL NOT BE BASED ON UN-APPROVED MATERIALS, EQUIPMENT, OR APPARATUS. UNAPPROVED MATERIAL, EQUIPMENT OR APPARATUS WILL NOT BE ACCEPTED.
- E. Should electrical, water, drain, natural gas, structural support, or other similar requirements for alternate equipment, whether named in the specifications or approved as a substitution, be different from requirements for the products used in laying out the project, such changes shall be the responsibility of the Contractor, and shall not result in extra charges to the Owner or Architect/Engineer.

1.24 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned for column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.25 PAINTING

- A. Field painting of mechanical equipment, duct systems, piping systems, etc., shall be accomplished under Division 09 of these specifications.
- B. Protection of Factory-applied Finishes:

1. Factory-applied finishes on equipment and apparatus installed on the project shall be carefully protected.
2. At the conclusion of the work, and prior to final acceptance of the project, equipment and apparatus shall be thoroughly cleaned of all construction dirt, oil and grease smears, temporary labels, debris, paint droppings, etc.
3. Damaged factory finishes shall be restored to their original condition using procedures, materials and application techniques as set forth in Division 09 found elsewhere in these specifications.

1.26 CLEANING

- A. Refer to the Division 01 Section: "CLOSEOUT PROCEDURES" for general requirements for final cleaning.
- B. Refer to Division 23 Section: "MECHANICAL TESTING, ADJUSTING, AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.
- C. Name Plates:
 1. All nameplates shall be protected from damage during the construction process.
 2. At the conclusion of the work, the nameplates shall be carefully cleaned and left in a fully legible condition.
- D. Removal of Rubbish: Each Contractor is responsible for the timely removal of rubbish and trash generated by his work, such as empty cartons, containers, materials crates, etc. Particular attention is called to residue that may present a potential tripping or injury hazard.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

- A. The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer's materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect 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, he shall bear all costs arising in connection with the deficiencies.
- B. The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.
- C. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions.

- D. Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriter's 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 these sections of the specifications 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.
- E. 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 Observation.
- F. 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 in. 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 coatings 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-6215.
- G. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.
- H. 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 thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect 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.

2.02 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. 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, steel treads, and workmen or their tools and equipment shall cover finished surfaces to prevent any damage 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 observation must be cleaned of rust and repainted as specified elsewhere in these specifications.

2.03 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 his work promptly and carefully 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.

2.04 PRECEDENCE OF MATERIALS

- A. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structural design of the building, which will fit into the available space, and which will insure complete and satisfactory systems. Each Contractor shall be responsible for the proper fitting of his material and apparatus into the building.
- B. Each Contractor shall so harmonize his work with that of the other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Piping interferences shall be handled by giving precedence to pipelines that require a stated grade for proper operation. Where space requirements conflict, the following order of precedence shall, in general, be observed:
 - 1. Building lines
 - 2. Structural members
 - 3. Soil and drain piping
 - 4. Vent piping
 - 5. Steam piping
 - 6. Condensate piping
 - 7. Refrigerant piping
 - 8. Electrical bus duct
 - 9. Supply ductwork
 - 10. Return ductwork
 - 11. Exhaust ductwork
 - 12. Chilled water and heating water piping
 - 13. Automatic Fire Protection Sprinkler Piping
 - 14. Natural gas piping

- 15. Domestic hot and cold water piping
- 16. Electrical conduit

2.05 LOCATION OF OUTLETS IN ROOMS

- A. All fire protection, plumbing, acoustical tile, diffusers, grilles, registers, and other devices shall be referenced to coordinated, established data points and shall be located to present symmetrical arrangements with these points and to facilitate the proper arrangements of acoustical tile panels and other similar panels with respect to the mechanical and electrical outlets and devices. Those mechanical and electrical outlets shall be referenced to such features as wall and ceiling furrings, balanced border widths, masonry joints, etc. Outlets in acoustical tile shall occur symmetrically in tile joints or in the center of whole tiles. When locations of mechanical and electrical devices shown on the Architect reflected ceiling plans need to be modified, the final determination of the exact location of each outlet and the arrangement to be followed shall be acceptable to the Architect.
- B. The drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with the other trades. The Architect reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.
- C. The Contractor, by submitting a bid on this work, sets forth that he has the necessary technical training and ability, and that he will install his work in a satisfactory and workmanlike manner which is up to the best standards of the trade, complete, and in good working order. If any of the requirements of the drawings and specifications are impossible of performance, or if the installation, when made in accordance with such requirements, will not perform satisfactorily, he shall report it to the Architect for correction promptly after discovery of the discrepancy.

2.06 CONNECTIONS FOR OTHERS

- A. This Contractor shall rough-in for and make all gas, water, steam, sewer, etc., connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in drawings provided by the equipment suppliers, along with 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 where required. In each water line serving an item of equipment or piece of machinery, provide a shut-off valve. On each drain not provided with a trap, provide a suitable trap.
- D. All pipefittings, 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 sheet metal ductwork, transition pieces, etc., required for a complete installation of vent hoods, exhaust hoods, etc., provided by others.

PART 3 - INSTALLATION

3.01 INSTALLATION METHODS

- A. All pipes shall be concealed in pipe chases, walls, furred spaces, or above the ceiling, unless otherwise indicated.
- B. Piping may be run exposed in mechanical rooms, janitors' closets, or storage spaces, but only where necessary. All exposed piping shall be run in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines.
- C. All piping shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified. Independently support all equipment, conduits, piping, etc. from building structure. Hangers and supports for equipment, piping, and conduits should be double nutted top and bottom.
- D. Where limited space is available above the ceilings and below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, in a manner to provide maximum above-floor clearance. Sleeves shall be as specified or as required.
- E. 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 plans, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces may be run at angles to the construction but shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.
- F. There shall be no pipe joints nearer than 12 in. to a wall, ceiling, or floor penetration, unless pipe joint is the welded type joint.
- G. The Contractor shall study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur, the Contractor shall meet with all involved trades and the Architect and resolve the conflict, prior to erection of any work, in the area involved.

3.02 CUTTING AND PATCHING

- A. Cut and patch openings through walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- B. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills at locations acceptable to the Architect. Impact-type equipment will not be used, except where specifically acceptable to the Architect. Openings in Precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled or cast to exact size.
- C. 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. 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.
- E. 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. No cutting, boring, or excavating, which will weaken the structure, shall be undertaken. NO STRUCTURAL MEMBER MAY BE CUT WITHOUT THE WRITTEN APPROVAL OF THE ARCHITECT.

3.03 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 plans, but shall 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 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 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 shall be removed. Pipe shall not be permitted to lie on the ground during storage. Pipe ends shall be sealed during storage.

3.04 IDENTIFICATION AND LABELING

- 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.
- B. All items of mechanical and electrical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16 in. thick, 3-ply, with black surfaces and white core. Engraving shall be condensed gothic, at least 1/2 in. 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:
 - 1. Terminal Units
 - 2. Miscellaneous similar and/or related items.

- C. The Contractor shall install identification tags to be affixed to those valves that have functions that are not obvious. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. The valve identification tags shall be brass discs, 2 in. in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

3.05 TESTS AND INSPECTIONS

- A. The Contractor shall, during the progress of the work and upon its completion, test his work and make all tests as required by the specifications, state, municipal and other authorities having jurisdiction of the work. Piping pressure tests shall be made before pipe is concealed or covered. Tests shall be made in the presence of authorities requiring tests. The Contractor shall pay all costs, inspection charges and fees required for the tests of his work.
- B. The Contractor shall provide all apparatus, temporary piping connection, etc., required for tests. The Contractor shall take all due precautions to prevent damage to the building or its contents incurred by such tests. The Contractor shall repair and make good at his own expense any damage caused by failures or leaks during the tests.
- C. Leaks, defects or deficiencies shall be repaired and/or replaced, and tests shall be repeated until the test requirements are complied with fully.
- D. All equipment shall be placed in operation and tested for proper automatic control before the final balancing of the system is started.
- E. 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 condition, test results, specified results, and any other pertinent data. Data shall be delivered to the Architect.

3.06 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 his portion of the work.

3.07 CLEANING AND PAINTING

- A. All equipment, piping, ductwork, grills, insulation, etc., in finished areas furnished and installed by the Contractor shall be painted. Finished areas include mechanical rooms, boiler rooms, and outside the building as well as occupied areas inside the building. Final painting is to be done by the General Contractor. This Contractor shall thoroughly clean all part of materials and equipment of cement, plaster, and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean.

- B. This Contractor shall thoroughly clean the finish on all parts of the materials and equipment with factory applied finishes. Exposed parts in equipment rooms, above crawl space slabs, and all other spaces except sealed chases and attics shall be thoroughly cleaned of cement, plaster and other materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. If the finish has been damaged, the Contractor shall re-paint to the satisfaction of the Architect.
- C. All canvas finishes shall be painted with one sizing coat if not already sized, containing a mildew resistant additive and Arabol adhesive prior to any other specified finish paint.
- D. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during painting operation.

3.08 ELECTRICAL PROVISIONS OF MECHANICAL WORK

- A. The extent of electrical provisions to be provided as mechanical work is indicated in other mechanical sections of the specifications, on the drawings and as further specified in this section.
- B. Starters, Controllers: In general, mechanical work includes furnishing combination starters. Controllers are specifically included as electrical work when mounted in motor control centers. Electrical work includes installation, mounting and wiring of starters and controllers that are furnished as mechanical work. Free standing, large motor controllers shall be set in place, on pads, as mechanical work.
- C. Electrical heating equipment shall be furnished complete with internal or integral fusing and subdivision of loads to comply with the NEC.
- D. Wherever possible, match the elements of the electrical provisions of mechanical work with similar elements of the electrical work specified in electrical sections of the specifications.
- E. Standards:
 - 1. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards to definitions of terminology herein.
 - 2. Comply with National Electrical Code (NFPA No. 70) for installation requirements.
 - 3. Comply with National Electrical Contractors Association (NECA) "Standard of Installation".

3.09 TEMPORARY FACILITIES

- A. Unless noted otherwise in the Supplementary General Conditions; provide temporary facilities.

3.10 EQUIPMENT INSTALLATION REQUIREMENTS

- A. All mechanical equipment shall be furnished and installed complete and ready for use.
- B. All mechanical equipment and appliances shall be installed in a manner that all Code required access and services space is provided. Coordinate exact position of equipment and appliances with routing of new ductwork and piping, and with all existing conditions to provide required clearances.

1. Ensure that a minimum of 30" deep and 30" wide working space is provided in front of the control side of each appliance and piece of air moving equipment.
2. Ensure that air moving equipment and appliance in attics are installed so that they also have Code required clear passageway.

END OF SECTION

**SECTION 23 0506
MECHANICAL DEMOLITION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Demolition of:
 - 1. HVAC air handling units and related ductwork.
 - 2. Grilles, registers, diffusers, variable air volume boxes.
 - 3. Plumbing fixtures and trim, specialties, equipment and associated piping.
 - 4. Fire protection equipment and associated piping.
 - 5. Hanger and support devices.
 - 6. All other appliances or devices associated with equipment or devices to be removed.
- B. Demolition of all power wiring and conduit from each mechanical item to be removed back to the point of supply.

1.02 QUALITY ASSURANCE

- A. Perform all demolition and removal work necessary to arrive at the arrangement shown on the Contract Drawings.
- B. Perform all operations in such a method to cause minimum damage to items to be relocated, salvaged, or to remain intact and in use.

1.03 JOB CONDITIONS

- A. Perform site repair and removal of salvaged items at times approved by the Owner. Accomplish repair and removal of items in a continuous and diligent manner in order to limit interference with Owner's on-going operations.
- B. Drawings may not indicate and specifications may not identify every item required to be moved or removed.
- C. Before submitting bids, visit and examine the site of the work and become familiar with the scope of the work and the details of the demolition work to be accomplished.
- D. Submittal of a bid will be evidence that such an examination has been made and the various details noted.
- E. Claims for extra compensation because of additional labor, materials, or equipment required because of difficulties encountered, will not be recognized unless items were concealed at time of inspection of the Contract Documents. Bring all such items to the attention of the Owner's Representative and the Architect for their disposition before continuing with the work.

- F. Execute demolition work in a manner to protect adjacent equipment and other existing items against damage.
- G. Provide and erect lights, barricades, warning signs, and other items as required for protection of the Owner's employees, building occupants, and the public.
- H. Maintain barricades in good condition throughout the project to substantial completion.
- I. Control the dust resulting from demolition to prevent it from spreading the occupied areas of the building and to avoid creating a nuisance in the immediate surrounding area.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PROTECTION

- A. Provide protection for all building elements, all items which are to remain, all occupants and all workers at all times, and in accordance with all requirements of the Owner.

3.02 PROTECTION OF BUILDING FROM THE WEATHER

- A. Maintain weather protection for the space(s) being worked in at all times, and in accordance with all requirements of the Owner.

3.03 DEMOLITION

- A. Perform demolition in accordance with all requirements of the Owner.

3.04 DISPOSITION OF MATERIALS

- A. Dispose of all demolition items and materials in a legal off-site location.

3.05 RELOCATION AND REUSE OF MECHANICAL ITEMS

- A. Relocate items indicated on the Contract Drawings as required to accommodate the new construction. Remove, relocate and reconnect equipment and accessories that are to be reused.
- B. Coordinate the work with the Electrical Contractor. Determine which items and equipment are to remain, to be relocated or to be removed. Perform the work consistent with the scope of the project.
- C. Transport and store materials removed and designated for relocation as directed by the Owner's Representative.
- D. Remove all salvage items not be reused or delivered to the Owner, from the property at the end of each workday.
- E. Maintain full water, drain, electrical service, etc., to all equipment and apparatus that remains in service in the building.

3.06 CLEANING

- A. Section 23 0010 - Basic Mechanical Requirements.

3.07 REMOVAL OF WATER

- A. Be responsible for the removal of water in areas in which scheduled work is to be performed.
 - 1. Remove water by pumping, siphoning, absorbent mopping, or compressed air brooming.
 - 2. Do not use any method of removal that will cause damage to new or reused adjacent equipment or materials.

3.08 SCHEDULING

- A. Schedule demolition in strict compliance with the Owner's instructions.

3.09 DISCONNECTION AND RECONNECTION OF UTILITIES

- A. Do not disconnect or reconnect any utilities until notifying the Owner's Representative.
- B. Notify the Electrical Contractor when requiring Electrical Disconnect or Reconnect.

END OF SECTION

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**SECTION 23 0512
MECHANICAL AND ELECTRICAL COORDINATION**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 26 05 10 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.
- B. Refer to Section 21 00 10 - BASIC FIRE PROTECTION REQUIREMENTS.
- C. Refer to Section 22 0010 - BASIC PLUMBING REQUIREMENTS.
- D. Refer to Section 23 0010 - BASIC MECHANICAL REQUIREMENTS.

1.02 SUMMARY

- A. This Section describes the coordination between the Fire Protection, Plumbing, Mechanical and Electrical portions of the work.
- B. This Section is included under the Division 21 portion of the Specifications as Section 21 05 12, under the Division 22 portion of the Specifications as Section 22 0512, under the Division 23 portion of the Specifications as Section 23 0512, and under the Division 26 portion of the Specifications as Section 26 05 12.

1.03 WORK INCLUDED

- A. Responsibility: Unless otherwise indicated, motors and controls shall be furnished, set in place and wired in accordance with the following schedule. **This schedule may include equipment and systems that are not required for this project. Only the equipment and systems that are required on the drawings and/or specified elsewhere will be required by this section:**

1.	Equipment Motors	21/22/2 3	21/22/2 3	26
2.	Magnetic Motor Starters			
	a. Automaticall y controlled, with or without HOA switches	21/22/2 3	26	Notes 1,3,5
	b. Automaticall y controlled, with or without HOA switches and furnished as	21/22/2 3	22/23	Notes 1,3,5

	part of factory wired equipment			
	c. Manually controlled	21/22/23	26	Notes 1,3,5
	d. Manually controlled and furnished as part of factory wired equipment	21/22/23	26	Notes 1,3,5
	e. Furnished in Motor Control Centers	26	26	Notes 1,3,5
3.	Variable Speed (Frequency) AC Drives	22/23	26	Notes 1,4,5
4.	Line voltage thermostats, time clocks, etc., not connected to control panel systems	23	26	23
5.	Electric thermostats, time clocks, remote bulb thermostats, motorized valves, float controls, etc. which are an integral part or directly attached to ducts, pipes, etc.	22/23	22/23	22/23
6.	Temperature control panels and	23	23	23

	time switches mounted on temperature control panels			
7.	Motorized valves, motorized dampers, solenoid valves, EP and PE switches, etc.	23	23	Note 1
8.	Alarm bells furnished with equipment installed by Division 22 or 23	22/23	22/23	22/23
9.	Wiring to obtain power for control circuits, including circuit breaker	21/22/2 3	21/22/2 3	21/22/2 3
10	Low voltage controls	21/22/2 3	21/22/2 3	21/22/2 3
11	Fire protection system (sprinkler) controls	21	21	Note 8
12	Fire and smoke detectors installed on mechanical units and in ductwork	28	23	Note 8
13	All relays required for fan shutdown,	23	23	Note 1

	motorized dampers, smoke control devices, and other items integral with HVAC equipment to provide operation and control of HVAC equipment			
14	Smoke dampers, and combination fire/smoke dampers	23	23	Note 7
15	Boiler and water heater controls, boiler burner controls panels	22/23	22/23	22/23
16	Pushbutton stations, pilot lights	22/23	22/23	22/23
17	Heat Tape	21/22/2 3	21/22/2 3	26
18	Disconnect switches, manual operating switches furnished as a part of the equipment	21/22/2 3	21/22/2 3	Notes 1,5
19	Disconnect switches, manual operating switches furnished separate from equipment	26	26	26

20	Multispeed switches	23	23	26
21	Thermal overloads	21/22/2 3	21/22/2 3	21/22/2 3
22	Control relays, transformers	21/22/2 3	21/22/2 3	21/22/2 3
23	Refrigeration cycle, cooling tower and controls	23	23	23
24	Tamper switches for fire protection (sprinkler) system	21	21	28
25	Flow and/or pressure switches for fire protection (sprinkler) system	21	21	28
26	Fire and jockey pump controllers and automatic transfer switch	21	21	Note 6
27	Alarm bells or horns for fire protection (sprinkler) system	21	21	28
28	Generator (underground) fuel tank	22	22	--
29	Generator fuel level indicator	22	22	26
30	Generator fuel piping from tank to generator	22	22	--

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31	Underground fuel tank leak detection and monitoring system	22	22	22	ITEM	FURNISHED UNDER DIVISION	INSTALLED UNDER DIVISION	WIRED AND CONNECTED UNDER DIVISION
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Notes:	(1)	Power wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 26; control wiring as defined in Section 26 29 13 of the specifications shall be provided under Division 21/22/23.
	(2)	Wiring from alarm contacts to alarm systems provided by Division 26, wiring from auxiliary contacts to air handling system controls provided by Division 23. Division 26 shall provide power to smoke detector. Smoke detectors required for all air handling systems 2000 CFM or greater. Refer to other Division 23 specifications, Division 26 and Drawings for more specific requirements.
	(3)	For requirements for Magnetic Motor Starters, refer to Section 23 89 65 - MOTOR CONTROLLERS.
	(4)	For requirements for Variable Speed (Frequency) AC drives, refer to Section 23 89 65 - MOTOR CONTROLLERS.
	(5)	Disconnect switches, operating switches, starters and other similar items that are factory-mounted, as a part of complete assembly, shall comply with applicable provisions of the National Electric Code. All such disconnect switches shall be fused.
	(6)	Power wiring from energy source to controllers and automatic transfer switch shall be provided under Division 26. Interconnection power and control wiring from controllers and automatic transfer switch to pumps shall be provided under Division 21, 22 or 23 and conforming to Division 26 specifications. Control wiring from automatic transfer switch to generator starter shall be provided under Division 26.
	(7)	Division 26 will provide power to all smoke and combination fire/smoke dampers, and Division 28 will provide control for all such dampers using area smoke detectors.
	(8)	Wiring for sprinkler system controls to be provided by Division 21. Wiring from devices to Fire Alarm System to be provided by Division 28.

B. Connections: Make all connections to controls that are directly attached to ducts, piping and mechanical equipment with flexible connections.

C. Precedence

1. In general, piping systems that require a stated grade for proper operation shall have precedence over other systems.
2. Precedence for pipe, conduit and duct systems shall be as follows.

- a. Building lines
 - b. Structural members
 - c. Soil and drain piping
 - d. Vent piping
 - e. Steam piping
 - f. Condensate piping
 - g. Refrigerant piping
 - h. Electrical bus duct
 - i. Supply ductwork
 - j. Return ductwork
 - k. Exhaust ductwork
 - l. Chilled water and heating water piping
 - m. Automatic Fire Protection Sprinkler Piping
 - n. Natural gas piping
 - o. Domestic hot and cold water piping
 - p. Electrical conduit
3. Lighting Fixtures shall have precedence over air grilles and diffusers.

D. Final Inspection and Report

1. At the completion of the work, there shall be a meeting of the Fire Protection, Plumbing, Mechanical, Electrical Fire Alarm and Temperature Control Contractors, representatives of mechanical and electrical equipment manufactures whose equipment was actually installed on the project, and similarly-involved individuals, who shall thoroughly inspect all systems, and who shall mutually agree that all equipment has been properly wired and installed, and that all temperature and safety controls are properly functioning. A written report of this meeting, listing those in attendance, and the companies that they represent, shall be filed with the Owner and Architect or Engineer.

END OF SECTION

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**SECTION 23 0529
MECHANICAL SUPPORTS AND ANCHORS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of supports and anchors required by this section is indicated on Drawings and/or specified in other Division 23 sections.
- B. Types of supports and anchors specified in this section include the following:
 - 1. Pipe and equipment hangers, supports, and anchors.
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. Code Compliance: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
 - 2. Fire Protection Compliance: Install in accordance with NFPA 13-latest edition. Provide products that are UL-listed and FM approved.
 - 3. MSS Standard Compliance:
 - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
 - b. Select and apply pipe hangers and supports, complying with MSS SP-69.
 - c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
 - d. Terminology used in this section is defined in MSS SP-90.
- C. All hangers, supports and attachments shall be manufactured with materials compatible with the environment in which they will be installed. Unless directed otherwise, all hangers, supports, and attachments installed exterior to the building or within high humidity environments shall be galvanized steel or stainless steel.
- D. Manufacturers of Hangers and Supports:
 - 1. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. B-Line Systems Inc. (Cooper)

- b. ANVIL International

1.03 SUBMITTALS

- A. Submit product data and maintenance data as required under provisions of Division 01 and Section 23 0010.
- B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.
- C. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 HORIZONTAL-PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
- B. Adjustable Steel Clevis Hangers: MSS Type 1.
- C. Yoke Type Pipe Clamps: MSS Type 2.
- D. Steel Double Bolt Pipe Clamps: MSS Type 3.
- E. Steel Pipe Clamps: MSS Type 4.
- F. Pipe Hangers: MSS Type 5.
- G. Adjustable Swivel Pipe Rings: MSS Type 6.
- H. Adjustable Steel Band Hangers: MSS Type 7.
- I. Adjustable Band Hangers: MSS Type 9.
- J. Adjustable Swivel Rings, Band Type: MSS Type 10.
- K. Split Pipe Rings: MSS Type 11.
- L. Extension Split Pipe Clamps: MSS Type 12.
- M. U-Bolts: MSS Type 24.
- N. Clips: MSS Type 26.

- O. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
 - 1. Plate: Unguided type.
 - 2. Plate: Guided type.
 - 3. Plate: Hold-down clamp type.
- P. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
- Q. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.
- R. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.
- S. Single Pipe Rolls: MSS Type 41.
- T. Adjustable Roller Hangers: MSS Type 43.
- U. Pipe Roll Stands: MSS Type 44.
- V. Pipe Rolls and Plates: MSS Type 45.
- W. Adjustable Pipe Roll Stands: MSS Type 46.

2.02 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
- B. Two-Bolt Riser Clamps: MSS Type 8.
- C. Four-Bolt Riser Clamps: MSS Type 42.

2.03 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
- B. Steel Turnbuckles: MSS Type 13.
- C. Steel Clevises: MSS Type 14.
- D. Swivel Turnbuckles: MSS Type 15.

- E. Malleable Iron Sockets: MSS Type 16.
- F. Steel Weldless Eye Nuts: MSS Type 17.

2.04 BUILDING ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
- B. Top Beam C-Clamps: MSS Type 19.
- C. Side Beam or Channel Clamps: MSS Type 20.
- D. Center Beam Clamps: MSS Type 21.
- E. Welded Beam Attachments: MSS Type 22.
- F. C-Clamps: MSS Type 23.
- G. Top Beam Clamps: MSS Type 25.
- H. Side Beam Clamps: MSS Type 27.
- I. Steel Beam Clamps W/Eye Nut: MSS Type 28.
- J. Linked Steel Clamps W/Eye Nut: MSS Type 29.
- K. Malleable Beam Clamps: MSS Type 30.
- L. Steel Brackets: One of the following for indicated loading:
 - 1. Light Duty: MSS Type 31, suspending 750 lbs. max.
 - 2. Medium Duty: MSS Type 32, suspending 1500 lbs. max.
 - 3. Heavy Duty: MSS Type 33, suspending 3000 lbs. max.
- M. Side Beam Brackets: MSS Type 34.
- N. Plate Lugs: MSS Type 57.
- O. Horizontal Travelers: MSS Type 58.

2.05 CONCRETE INSERTS

- A. Cast-In-Place Spot Type: Malleable iron, or steel with recommended insert nut. Size inserts nut to suit threaded hanger rod. MSS SP-69, Type 18.
- B. Drill-In Spot Type: Steel, attached wedge, lock washer and nut. Size inserts to suit threaded hanger rod.

1. Acceptable Manufacturers and Models:
 - a. Hilti "Kwik Bolt"
 - b. Ramset "Wedge Anchor"
 - c. Rawl "Stud"
- C. Continuous Channel Type: Steel, anchoring lugs, with channel nuts, rated for 2000 lbs. per foot minimum load. Size channel nut to suit threaded hanger rod.
 1. Acceptable Manufacturers and Models:
 - a. B-Line B22
 - b. Elcen 1150
 - c. Unistrut P3200

2.06 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
- C. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal Hanger Shields: Constructed of 360° insert of high density, 125-psi compressive strength, and water-proofed calcium silicate, encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation.
 1. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.

2.07 SPRING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated spring hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select spring hangers and supports to suit pipe size and loading.
- B. Restraint Control Devices: MSS Type 47.
- C. Spring Cushion Hangers: MSS Type 48.

- D. Spring Cushion Roll Hangers: MSS Type 49.
- E. Spring Sway Braces: MSS Type 50.
- F. Variable Spring Hangers: MSS Type 51; preset to indicated load and limit variability factor to 25%.
- G. Variable Spring Base Supports: MSS Type 52; preset to indicated load and limit variability factor to 25%; include load flange.
- H. Variable Spring Trapeze Hangers: MSS Type 53; preset to indicated load and limit variability factor to 25%.
- I. Constant Supports: Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.
 - 1. Horizontal Type: MSS Type 54.
 - 2. Vertical Type: MSS Type 55.
 - 3. Trapeze Type: MSS Type 56.

2.08 MISCELLANEOUS MATERIALS

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Auxiliary Steel: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
- E. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.09 SLEEVES, INSETS AND FASTENINGS

- A. Pipes passing through concrete or cinder walls and floor or other corrosive material shall be protected by a protective sheathing or wrapping or by sleeves, as required to meet the local code. Annular spaces between sleeves and pipes shall be filled or tightly caulked in an approved manner. Annular spaces between sleeves and pipes in fire-resistance-rated assemblies shall be filled or tightly caulked in accordance with the local code.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at all changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Install additional at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at all changes in direction of piping. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire-water piping independently of other piping.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports that are copper plated, or by other recognized industry methods.

- E. Support and laterally brace vertical pipe runs at every floor level and at intervals not to exceed 20 ft. 0 in. Support vertical pipe with riser clamps installed below hubs, couplings or lugs welded to the pipe.
- F. Provisions for Movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
 - 2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
- G. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Piping hangers shall be sized large enough to allow insulation to pass through. Hangers for piping 2-1/2 in. and greater shall be provided with pipe covering protection saddle, or high compressive strength insulation saddle. Hangers for piping 2 in. and less shall be provided with pipe covering shields. On cold or chilled water piping provide vapor barrier through hanger.
 - 3. Do NOT utilize "pipe size" hangers or clamps with insulation placed over the pipe and hanger or clamp.
- H. Unless directed otherwise, all hangers, supports, and attachments installed exterior to the building or within high humidity environments shall be galvanized steel or stainless steel.

3.05 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.06 ADJUSTING AND CLEANING

- A. Hanger Adjustments: Adjust hangers so as to distribute loads equally on attachments.
- B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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**SECTION 23 0553
MECHANICAL IDENTIFICATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of mechanical identification work required by this section is indicated on Drawings and/or specified in other Division 23 sections.
- B. Types of identification devices specified in this section include the following:
 - 1. Plastic Pipe Markers.
 - 2. Plastic Duct Markers.
 - 3. Valve Tags.
 - 4. Valve Schedule Frames.
 - 5. Engraved Plastic-Laminate Signs.
- C. Mechanical identification furnished as part of factory-fabricated equipment, is specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for identification requirements at central-station mechanical control center; not work of this section.
- E. Refer to Division 26 sections for identification requirements of electrical work; not work of this section.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2 in. x 11 in. bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 01.
- D. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 - 1. Allen Systems, Inc.
 - 2. Brady (WHO) Co.; Signmark Div.
 - 3. Industrial Safety Supply Co., Inc.
 - 4. Seton Name Plate Corp.

2.02 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.03 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, and pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.
- C. Insulation: Furnish 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on un-insulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2 in. beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6 in. (including insulation if any), provide full-band pipe markers, extending 360° around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 in. wide; full circle at both ends of pipe marker, tape lapped 1-1/2 in.
- E. Large Pipes: For external diameters of 6 in. and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 in. wide; full circle at both ends of pipe marker, tape lapped 3 in.
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Lettering: Manufacturer's standard pre-printed nomenclature that best describes piping system in each instance, as selected by Architect in cases of variance with name as shown or specified.
- G. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.
1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.04 PLASTIC DUCT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, color-coded duct markers. Conform to the following color code:
1. Green: Cold air.
 2. Yellow: Hot air.
 3. Yellow/Green: Supply air.
 4. Blue: Exhaust, outside, return, and mixed air.
 5. For hazardous exhausts, use colors and designs recommended by ANSI A13.1.
- B. Nomenclature: Include the following:
1. Direction of airflow.
 2. Duct service (supply, return, exhaust, etc.).
 3. Duct origin (from).
 4. Duct destination (to).
 5. Design CFM.

2.05 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4 in. high letters and sequenced valve numbers 1/2 in. high, and with 5/32 in. hole for fastener.
 - 1. Provide 1+ in. diameter tags, except as otherwise indicated.
 - 2. Provide size and shape as specified or scheduled for each piping system.
 - 3. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16 in. thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 in. center hole to allow attachment.

2.06 VALVE SCHEDULE FRAMES

- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.07 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16 in. for units up to 20 sq. in. or 8 in. length; 1/8 in. for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.08 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
 - 1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification that indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces that require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork with duct markers showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacings along exposed runs.
- C. Access Doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.
- D. Concealed Doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticize tags may be installed for identification in lieu of specified signs, at Installer's option.

3.03 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures on both sides of penetration.
 - 4. At access doors, manholes and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced intermediately at maximum spacing of 20 ft. along each piping run, except reduce spacing in congested areas of piping and equipment, where required for clarity.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

C. Piping Identification

1. Provide piping identification for the following:

System	Background Color	Text Color
Chilled Water Supply	Green	White
Chilled Water Return	Green	White
Heating Water Supply	Green	White
Heating Water Return	Green	White
Condenser Water Supply	Green	White
Condenser Water Return	Green	White
Pumped Condensate Return	Yellow	Black
Steam (___* psi)	Yellow	Black
Condensate Return (* psi)	Yellow	Black

2. Contractor shall identify specific pressure for each steam system.

3.04 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
 1. Tagging Schedule: Comply with requirements of "Valve Tagging Schedule" at end of this section.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect.
 1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.
- C. Valves shall be labeled on ceiling grid or any access panel for location verification.

3.05 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 1. Terminal units.

- B. Lettering Size: Minimum 1/4 in. high lettering for name of unit where viewing distance is less than 2 ft. 0 in., 1/2 in. high for distances up to 6 ft. 0 in., and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
- C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.06 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device, which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.07 EXTRA STOCK

- A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 - 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION

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SECTION 23 0593
MECHANICAL TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 SUMMARY

- A. Adjust and balance Mechanical Water systems
- B. Adjust and balance Mechanical Air systems
- C. Check each piece of operating equipment provided under Division 23.
- D. Provide Balancing Report

1.02 QUALITY ASSURANCE

- A. Independent Subcontractor: All testing, adjusting and balancing shall be performed by a Testing, Adjusting and Balancing firm that is independent from the HVAC systems installer.
- B. Balancing Work: Under direct supervision of AABC accredited testing organization certified supervisor.

1.03 REFERENCES

- A. Reference Standards: Comply with AABC National Standards for Total System Balance, latest edition.

1.04 SUBMITTALS

- A. Certificate: Before beginning work, submit certification of AABC certified supervisor and AABC firm certification in accordance with Section 23 0010.
- B. Balancing Report: At completion of work, submit balancing report in accordance with Section 23 0010. After adjustments have been made submit three (3) copies of a complete detailed report on mechanical systems and their operation to include:
 - 1. Blackline prints with air openings marked to correspond with data sheets and with thermometer locations clearly marked.
 - 2. Data sheets showing amount of air handled at each opening, instrument used, velocity readings and manufacturer free area factors.
 - 3. Equipment data sheets giving make, size, etc., of fans, motors and drives. Include supply fans, exhaust and recirculating fans.
 - 4. Operating data including fan RPM, measured motor current and voltage BHP and CFM (total).
 - 5. Equipment and operating data at each section of the unit and at the unit connection points including air temperatures entering and leaving coils (maximum air temperature rise), together with corresponding air flow and air pressure drop, water temperatures entering and leaving coils and water pressure drop through coil.

6. Equipment and operating data as required to show performance of H&V units, fan coils, cabinet heaters, unit heaters, temperature control devices, pumps and domestic hot water circulating systems.
7. Static pressure loss across variable air volume boxes and associated reheat coils.
8. Prime source refrigeration equipment operating data at design conditions including temperature measurements, flow conditions and corresponding power consumption.
9. A statement outlining any abnormal or notable conditions not covered in above data.
Make special note of any discrepancies between tabulated data and specified conditions.

1.05 PROJECT CONDITIONS

- A. Existing Conditions: Verify following conditions before proceeding with work:
 1. Installation of the designated system is complete and in full operation.
 2. Outside temperature conditions, occupant loads, lighting loads, special equipment requiring extra sensible or ventilation requirements, and solar conditions are within a reasonable range relative to design conditions.

PART 2 - PRODUCTS

2.01 INSTRUMENTS

- A. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations and requirements of AABC.
- B. Calibration histories for each instrument shall be available for examination.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect preceding work in accordance with Section 23 0010 BASIC MECHANICAL REQUIREMENTS.

3.02 PREPARATION

- A. Water Systems: Check:
 1. Strainers are clean.
 2. Automatic control valves operation.
 3. Pump rotation.
 4. Other conditions as required.
- B. Air Systems: Check:
 1. Filters are clean.

2. Filter leakage.
3. Damper operation and leakage.
4. Duct leakage.
5. Fan rotation.
6. Equipment vibration.

3.03 ADJUSTING AND BALANCING

- A. General: Check, adjust and balance air and water system to meet the design performance and tabulate results on acceptable forms. Minimum data to include amperage, voltage input, and thermal heater capacity of each motor, equipment nameplate data and operating speed, pressure drop across each filter bank, pressure rise across each fan and pump, CFM capacity each outlet, zone and fan, and heating or cooling capacity of each coil or element.
- B. Belt Drives: Adjust so that when the desired speed and belt tension had been established, the variable speed pulley and the belt tension adjustment shall be at approximately the midpoint of their range.
- C. Water Balance and Equipment Test: Include circulating pumps, converters, coils, coolers, chillers, boilers and condensers.
 1. Coordinate water chiller flow balancing with chiller equipment manufacturer and design requirements.
 2. Adjust flow rates for equipment, coils and evaporator for instance, to values on equipment submittals if different from values on Contract Drawings.
 3. Primary-secondary (variable volume systems: Coordinate TAB with Controls Sequence of Operation. Balance systems at design flow then verify that variable flow controls function properly.
 4. Record final measurements for hydronic equipment performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, chiller evaporators and condensers, boilers and for converters. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.
- D. Air Systems:
 1. Adjust dampers for the delivery and distribution of air quantities indicated on the drawings.
 2. Mark balancing device at final setting.
 3. Replacement of adjustable pulleys, installation of additional balancing dampers or pressure taps, required to effect proper air balance shall be furnished and installed by the HVAC Contractor at no additional cost to the Owner.

4. Adjust exhaust and recirculation air systems for air quantities indicated on drawings and to establish the proper relationship between supply and exhaust.
5. Adjust distribution system to obtain uniform space temperature free from objectionable drafts and noise within the capabilities of the system.
6. Acceptable Tolerances: Adjust fan systems, air devices, etc. as follows:
 - a. Supply air fan CFM: -5% to +5% of scheduled
 - b. Return air fan CFM: -5% to +5% of scheduled
 - c. Exhaust air fan CFM: -0% to +10% of scheduled
 - d. Supply air device CFM: -10% to +10% of scheduled
 - e. Return air device CFM: -10% to +10% of scheduled
 - f. Exhaust air device CFM: -0% to +10% of scheduled
 - g. Outside air CFM: -0% to +10% of scheduled
- E. Test Run: In order to determine that the system installation is complete and will operate satisfactorily, make a test run with equipment operating per normal temperature control schedule and sequence. Run test and operate and adjust equipment as may be required during test run.

3.04 COMPLETION SERVICES

- A. Final Check: Make final checks and do any rebalancing as directed.
- B. Report: Submit Balancing Report as specified above.
- C. Acceptance: Final acceptance of the project will not be made until a satisfactory report is received. Owner reserves the right to spot check the report by field verification prior to final acceptance.

END OF SECTION

**SECTION 23 0713
HVAC DUCT INSULATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of mechanical insulation required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Ductwork System Insulation:
 - a. Fiberglass
- C. Refer to Section 23 0529 - MECHANICAL SUPPORTS AND ANCHORS for protection saddles, protection shields, and thermal hanger shields; not work of this section.
- D. Refer to Section 23 3113 - METAL DUCTWORK for duct linings; not work of this section.
- E. Refer to Section 23 0553 - MECHANICAL IDENTIFICATION for installation of identification devices for piping, ductwork, and equipment; not work of this section.

1.02 REFERENCES

- A. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
- B. NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- C. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.
- D. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
- F. ASTM E119 Standard Test Method for Fire Tests of Building Construction and Materials.
- G. ASTM E136 Standard Test Method for Behavior of materials in a Vertical Tube Furnace at 750°C.
- H. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- I. ASTM C411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- J. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- K. ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- L. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

- M. ASTM C 916 Standard Specification for Adhesives for Duct Thermal Insulation.
- N. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- O. ASTM C1290 Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC.
- P. ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Flame/Smoke Ratings: Provide composite mechanical (insulating material, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (UL723) method.
- D. Insulations shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or poly-brominated diphenyl ether fire retardants.
- E. Fiberglass insulations shall have a minimum of 50 percent recycled glass content; certified and UL Validated.
- F. Fiberglass insulations shall have a bio-based, formaldehyde-free binder and be UL GREENGUARD Gold certified.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide fiberglass products of one of the following:
 - 1. Certainteed.
 - 2. Manson.
 - 3. Knauf.
 - 4. Johns Manville.
 - 5. Owens-Corning.
- B. Manufacturer: Subject to compliance with requirements, provide grease duct insulation products of one of the following:
 - 1. Morgan Thermal Ceramics.
 - 2. UNIFRAX.
 - 3. 3M.
 - 4. Johns Manville.

2.02 DUCTWORK INSULATION MATERIALS

- A. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Type IA.
- B. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I
- C. Jackets for Ductwork Insulation: ASTM C 921, Type I (vapor barrier) for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.
 - 1. Encase exterior ductwork insulation with aluminum jacket with weatherproof construction, as specified.
- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

- B. Thickness of insulation shall be as recommended by the manufacturer for the temperatures and duct sizes involved, and in accordance with standards of NAIMA.

3.02 DUCTWORK SYSTEM INSULATION

- A. Insulation Omitted: Do not insulate fibrous glass ductwork or lined ductwork.
- B. Dual Temperature Ductwork:
 - 1. Application Requirements: Insulate the following dual temperature ductwork:
 - a. Hot/cold supply and return ductwork between fan discharge or HVAC unit discharge and room terminal outlets; except omit insulation on return air ductwork located in return air ceiling plenums.
 - 2. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:
 - a. Rigid Fiberglass: 1-1/2 in. thick, increase thickness to 2 in. in machine, fan and equipment rooms.
 - b. Flexible Fiberglass: 2.2 in. thick, application limited to concealed locations. Flexible insulation will not be used in machine, fan and equipment rooms.
- C. Ductwork insulation density and thickness shall comply with applicable IECC requirements: Minimum installed R-value of 6.0 inside the building envelope, R-value of 8.0 outside the building envelope.

3.03 INSTALLATION OF DUCTWORK INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
- E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
- F. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed to meet IECC requirements.
- G. Corner Angles: Except for oven and hood exhaust duct insulation; install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.04 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.05 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

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**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of mechanical insulation required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of mechanical insulation specified in this section include the following:
 - 1. Piping System Insulation:
 - a. Fiberglass.
- C. Refer to Section 22 0529 "PLUMBING SUPPORTS AND ANCHORS" for protection saddles, protection shields, and thermal hanger shields; not work of this section.
- D. Refer to Section 23 3113 "METAL DUCTWORK" for duct linings; not work of this section.
- E. Refer to Section 23 0553 "MECHANICAL IDENTIFICATION" for installation of identification devices for piping, ductwork, and equipment; not work of this section.

1.02 REFERENCES

- A. North American Commercial and Industrial Insulation Standards. 9th Edition or Latest Edition. Published by Midwest Insulation Contractors Association (MICA).
- B. NAIMA CI228 Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation 33°F to 60°F (0.5°C to 15.6°C) First Edition, 2015. Published by North American Insulation Manufacturers Association (NAIMA).
- C. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.
- D. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- E. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
- F. ASTM C335 Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
- G. ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- H. ASTM C547 Standard Specifications for Mineral Fiber Pipe Insulation.
- I. ASTM C585 Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- J. ASTM C795 Standard Specifications for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

- K. ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- L. ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Flame/Smoke Ratings: Provide composite mechanical (insulating material, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (UL 723) method.
- D. Insulations shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or poly-brominated diphenyl ether fire retardants.
- E. Fiberglass insulations shall have a minimum of 50 percent recycled glass content; certified and UL Validated.
- F. Fiberglass insulations shall have a bio-based, formaldehyde-free binder and be UL GREENGUARD Gold certified.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.
- B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - FIBERGLASS PRODUCTS

- A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
 - 1. Knauf Insulation.

2. Johns Manville Products Corp.
3. Owens-Corning Fiberglass Corp.
4. Manson Insulation.

2.02 PIPING INSULATION MATERIALS

- A. Fiberglass Piping Insulation: ASTM C 547, Type 1 unless otherwise indicated.
- B. Jackets for Piping Insulation: ASTM C 921 and ASTM C 1136, Type I (Vapor Barrier) for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installer's option.
 1. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per manufacturer's recommendations, ASTM D 1784.
 2. Encase exterior piping insulation with aluminum jacket with weather-proof construction, ASTM C 1729.
- C. Staples, Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
- D. Adhesives, Sealers and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Thickness of insulation shall be as recommended by the manufacturer for the temperatures and pipe sizes involved, and in accordance with standards of NAIMA.

3.02 HVAC PIPING SYSTEM INSULATION

- A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections and expansion joints.
- B. Hot Temperature Piping (40° to 200°F (4.4° to 94°C)):
 1. Application Requirements: Insulate the following dual temperature HVAC piping systems:
 - a. HVAC hot water supply and return piping.
 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

- a. Fiberglass: 1-1/2 in. thick for pipe sizes up to and including 1-1/4 in., 2 in. thick for pipe sizes over 1-1/4 in.

3.03 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-retarder jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 in. wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 in. wide vapor barrier tape or band.
- I. Do NOT insulate over pipe hangers. If pipe hangers for piping to be insulated are not adequately sized for insulation to pass through the hanger, notify the General Contractor and Architect.

3.04 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.05 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation that cannot be repaired satisfactorily, including units with vapor barrier damage and moisture-saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

**SECTION 23 0923
BUILDING CONTROL SYSTEM (BCS)**

PART 1 - GENERAL

1.01 GENERAL

- A. All work shall be in accordance with Division 01 and Section 23 0010 "BASIC MECHANICAL REQUIREMENTS".
- B. The project scope includes extending the existing Schneider Electric Building Controls System to serve equipment within the renovated project area.

1.02 SCOPE OF WORK

- A. Furnish all labor, materials, tools, equipment, and services for a fully integrated Building Control System (BCS) as indicated, in accordance with the Contract Documents.
- B. The BCS shall fully integrate third-party manufacturers control subsystems (i.e., boilers, chillers, etc.), which shall be capable of operating in a standalone mode, while being software integrated to comprise the complete BCS.
- C. Deliver the following features, hardware, and functions as a minimum:
 - 1. One Network Control Panel (NCP) for each major piece of equipment such as chillers, boilers, cooling towers, etc.
 - 2. One Application Specific Controller (ASC) for each air-handling unit, packaged rooftop unit, make-up air unit, fan coil unit, etc.
 - 3. Integration to third-party manufacturers' microprocessor controllers, as specified herein.
 - 4. Furnish and install all sensors, transducers, and controlled devices per this specification.
 - 5. Furnish all automatic control valves for installation by the Mechanical Installer. Furnish and install all control damper and control valve actuators.
 - 6. All monitoring, controlling, optimizing, interfacing, reporting, archiving, operator interface and information formulation and other special packages as required by the Contract Documents, including but not limited to the following:
 - a. Scheduled stop/start.
 - b. Optimum start/stop.
 - c. Run time totalization.
 - d. Duty cycling.
 - e. Load restoration following a fire alarm.
 - f. Automatic alarm lockout.
 - g. Password access control.

- h. Graphics display.
- i. Dynamic graphical trending.
- j. Historical data recording and reporting.

1.03 CONTRACTOR QUALIFICATIONS

- A. An integrated BCS will only be considered for acceptance from the following companies:
 - 1. Schneider Electric
- B. The BCS shall be installed by competent mechanics and commissioned by competent technicians regularly employed by the equipment vendor.
- C. Provide installation, calibration, and check-out of the stand-alone subsystems; as well as the complete operation of the integrated BCS, including graphics generation, implementation of point history feature and energy management applications.
- D. Maintain local support facility with technical staff, spare parts inventory, and all necessary test diagnostic equipment.

1.04 REFERENCED STANDARDS, CODES, AND ORDINANCES

- A. It is the responsibility of the Contractor to be familiar with all codes, rules, ordinances, and regulations of the authority having jurisdiction and their interpretations that are in effect at the site of the work.
- B. All systems equipment, components, accessories, and installation hardware shall be new and free from defects and shall be UL listed where applicable. All components shall be in current production and shall be a standard product of the system or device manufacturer. Refurbished or reconditioned components are unacceptable. Each component shall bear the make, model number, device tag number (if any), and the UL label as applicable. All system components of a given type shall be the product of the same manufacturer.

1.05 SUBMITTALS

- A. Provide submittal data as referenced in Division 01 and Section 23 0010 of these Contract Documents.
- B. Shop drawings shall include the installation details for all equipment to be furnished or provided under this Contract. At minimum, the shop drawings shall include details of:
 - 1. BCS architecture schematic (riser diagram).
 - 2. Interconnection and installation drawings and schedules, including bill of materials and sequences of operation.
 - 3. Field panel, plan location and interconnection drawings and specification sheets.
 - 4. Proposed panel loading and spare capacity.
 - 5. Instrumentation locations marked on Mechanical Drawings.

6. Schematic of monitored/controlled systems indicating device locations.
 7. Device installation details.
 8. Other documentation as appropriate.
- C. Product data submittals shall include the specifications for all equipment and software to be furnished or provided under this Contract. In addition, the submittals shall include details of:
1. Field sensors and instrumentation specification sheets.
 2. Valve and actuator specifications sheets.
 3. Wiring specifications.
 4. Other documentation as appropriate.

PART 2 - PRODUCTS

2.01 GENERAL DESCRIPTION

- A. The BCS shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, lighting control, information management, and historical data collection and archiving as well as trending.
- B. The BCS shall consist of the following:
 1. Network Control Panels (NCPs)
 2. Application Specific Controllers (HVAC, TUC, etc.)
- C. System shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, Network Control Panels, and operator devices.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each NCP and ASC shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection as well as trending. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- E. Network Control Panels shall be able to access any data from, or send control commands and alarm reports directly to, any other controller on the network without dependence upon a central processing device, such as a central file server. Network Control Panels shall also be able to send alarm reports to multiple operator workstations, terminals, and printers without dependence upon a central processing device or file server.

2.02 NETWORKING/COMMUNICATIONS

- A. The design of the BCS shall network Operator workstations (fixed and portable) and Network Control Panels. Inherent in the system's design shall be the ability to expand or modify the network.
- B. Local Area Network

1. Workstation/Network Control Panel Support. Operator workstations and NCPs shall directly reside on a single shared high-speed local area network such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.
2. Dynamic Data Access. All operator devices, either network resident or connected via the internet, shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.
3. General Network Design. Network design shall include the following provisions:
 - a. High-speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices.
 - b. Support of any combination of controllers and Operator workstations directly connected to the local area network.
 - c. Detection and accommodation of single or multiple failures of workstations, NCP, or the network media. The network shall include provisions for automatically reconfigure itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.
 - d. Message and alarm buffering to prevent information from being lost.
 - e. Error detection, correction, and re-transmission to guarantee data integrity.
 - f. Default device definition to prevent loss of alarms or data and to ensure alarms are reported as quickly as possible in the event an operator device does not respond.
 - g. Automatic synchronization for the real-time clocks in all NCPs and ASCs shall be provided.

2.03 NETWORK CONTROL PANELS

- A. Network Control Panels shall be microprocessor-based, multi-tasking, multi-user, real-time digital control processors. Each NCP shall consist of modular hardware with plug-in enclosed processors, communication, controllers, power supplies, and input/output modules. A sufficient number of controllers shall be provided to fully meet the requirements of this specification and the attached point list. The BCS point capacity shall be capable of being expanded by 200% by the addition of NCPs and ASCs. The BCS shall also support an additional two workstations above those specified herein.
- B. Each NCP shall have sufficient memory to support its own operating system and databases including:
 1. DDC and other control Processes
 2. Energy Management Applications
 3. Alarm Management

4. Historical/Trend Data for all points
 5. Maintenance Support Applications
 6. Custom Processes
 7. Operator I/O
 8. Network Communications
 9. Manual Override Monitoring
- C. Each NCP shall support the following types of point inputs and outputs:
1. Digital inputs for status/alarm contacts.
 2. Digital outputs for on/off equipment control.
 3. Analog inputs for temperature, pressure, humidity, flow, and position measurements.
 4. Analog outputs for valve and damper modulation, and capacity control of primary equipment.
 5. Pulse inputs for pulsed contact monitoring.
- D. The BCS shall be modular in nature and shall permit expansion through the addition of software applications, workstation hardware, field controllers, sensors, and actuators. The system architecture shall support 200% expansion capacity of all types of DDC panels and all point types included in the initial installation.
- E. Surge and transient protection shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with UL 1449.
- F. In the event of the loss of normal power, there shall be an orderly shutdown of all Network Control Panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the NCP shall automatically resume full operation without manual intervention.

2.04 SYSTEM SOFTWARE FEATURES

- A. General
1. System software feature shall be an expansion of the existing BMS. All necessary software to form a complete operating system as described in this specification shall be provided.
 2. The software programs shall be provided as an integral part of the NCP or ASC and shall not be dependent upon any higher-level computer for execution.

2.05 APPLICATION SPECIFIC CONTROLLERS

A. HVAC Controllers.

1. Each Network Control Panel shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).
2. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, and real-time digital control processor.
3. Each ASC shall have sufficient memory to support its own operating system and data bases including:
 - a. Control Processes
 - b. Energy Management Applications
4. Powerfail Protection. All system set points, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
5. Configuration Upload and Download. The ASCs shall have the capability of receiving configuration and program loading by all of the following: 1) locally, via a direct connect portable laptop service tool, 2) over the network, from the portable laptop service tool; and 3) from the Operator Workstation(s), via the communication networks.

B. Terminal Unit Controllers

1. Provide a terminal unit controller (TUC) for each terminal unit identified on the mechanical drawings.
2. Terminal unit controllers shall comply with the requirements specified above for Application Specific Controllers.
3. The terminal unit manufacturer shall provide the following components to ensure that each terminal unit is provided with a pressure independent control system.
 - a. Multi-point flow averaging sensor for primary airflow rate monitoring.
 - b. Flow rate calibration curves.
 - c. 24 Vac transformer for terminal unit controller power supply.
 - d. 24 Vac relay for on/off control of fan (as applicable).
 - e. 24 Vac relay(s) for electric heating coil control (as applicable).
 - f. Interlocks between the fan motor and the electric heating coil (as applicable).
 - g. Manual fan speed adjustment (as applicable).
 - h. Sheetmetal DDC controller enclosure.

- i. Terminal unit primary air dampers.
4. Furnish and field install the following terminal unit control components:
 - a. Terminal unit DDC controller.
 - b. Damper motors for the primary air damper.
 - c. Hot water coil control valve (as applicable).
5. Field calibrates the differential pressure transducer used to monitor the terminal unit primary airflow rate. Coordinate calibration with the balancing of the air distribution systems. Ensure overall primary air flow measurement accuracy of +/- 5% for primary air velocities in the range of 400 ft. per minute to 3000 ft. per minute.
6. Control of the primary air dampers and heating coils (electric or hot water, as applicable), shall be by direct digital control using a proportional plus integral control algorithm, at minimum. Maintain the space temperature set point to within +/- 1°F, when either in the heating or cooling mode.
7. All terminal unit communication cabling shall be routed through cable rings to avoid cable damage due to ductwork, hangers, etc. Communication cabling shall be provided with a heavy insulation jacket and shall be orange or another unique color. Coordinate cable jacket color with all other trades.
8. The sequences of operation shall be resident at the TUC or in the supervisory NCP for the various modes of operations:
 - a. Normal occupied mode.
 - b. Night setback mode.
 - c. Morning warm-up mode.
 - d. Morning cool-down mode.
9. The controller shall incorporate the necessary input subsystems to enable monitoring of the following parameters:
 - a. Space temperature.
 - b. Primary airflow rate. Flow rate shall be displayed at the BCS Operator terminals in c.f.m.
10. The controller shall incorporate the necessary output subsystems to enable control of the following terminal unit parameters:
 - a. Damper modulation. For morning warm-up, terminal unit primary air damper shall be fully closed. For morning cool down the primary air damper shall be open to the maximum flow rate position.
 - b. Electric heating coil control (where applicable).

2.06 INTEGRATION WITH THIRD-PARTY MANUFACTURER CONTROLLERS

- A. Interoperability With Equipment Controllers.
 - 1. The BCS shall be capable of interoperating with multiple building systems supplied by different manufacturers. The BCS shall be able to receive, react to, and send information from/to multiple equipment controllers.
 - 2. The system shall allow the custom generation of third-party vendor code on a local level to permit any system to be fully integrated into the BCS network.
 - 3. Input and output points from the third-party controllers shall have real-time interoperability with BCS software features such as Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications, as described previously in the contract documents.
- B. Networking/Communications.
 - 1. The BCS shall support any combination of third-party controllers (if more than one third-party manufacturer is being integrated) on a single network.
 - 2. A minimum of 100 third-party controllers shall be supported on a single network, or as dictated by the third party system architecture.
 - 3. Integration shall be by RS-485 technologies.
- C. Verify and diagnose communication messages and point information between third-party controllers and the BCS.
- D. The BCS shall be able to monitor and control third-party controller point inputs and outputs as defined in the I/O point schedule.

2.07 OPERATOR INTERFACE

- A. This shall be an expansion of the existing BMS software/user interface features.

2.08 INSTRUMENTATION

- A. Temperature Sensors/Transducers.
 - 1. Provide only one of the following temperature sensor types throughout:
 - a. Thermistor (10k Type II or III)
 - 2. All temperature sensors shall be constructed as follows:
 - a. Cable with a single end grounded.
 - b. Waterproof sensor to sheath seal.
 - c. Strain minimizing construction.

3. All sensors provided shall meet the following overall end-to-end accuracy requirements whether or not temperature transducers are provided, under all normal building ambient conditions:
 - a. Temperatures less than 100°F shall be reported by the BCS with an accuracy of 0.5°F.
 - b. Temperatures greater than 100°F shall be reported by the BCS with an accuracy of 1.0°F.
 - c. Averaging temperature sensors shall be reported by the BCS with an accuracy of 1.0°F.
 - d. Drift shall not exceed the accuracy requirements over a 5-year period.
4. Thermowell mount elements shall meet the following additional requirements.
 - a. Stainless steel sheath suitable for the pressure rating of the system.
 - b. Length shall be suitable for application.
 - c. Furnish thermowells and all other accessories required for the temperature sensor. The Mechanical Installer shall supply Wells for installation. Thermowells shall be stainless steel or chrome plated brass construction of size to suit sensor and pipe and shall be rated for the maximum pressure imposed on the various water systems. Verify and certify that the material of construction will not cause any galvanic corrosion.
 - d. Each chilled or hot water supply temperature sensor shall be matched to within 0.2°F over the range of 32°F to 68°F with the associated return water temperature sensor.
5. Outside air temperature sensor shall meet the following additional requirements:
 - a. Complete with non-corroding outdoor shield designed to minimize the effect of solar heating on the temperature sensor element.
 - b. Water proof seal.
 - c. Threaded fittings for mating to conduit.
6. Duct mounted temperature sensors shall meet the following additional requirements:
 - a. Copper sheathed construction.
 - b. Length shall be such that the element is between 1/3 and 2/3 the distance across the duct from all sides.
 - c. Ascertain the recommended location of supply air temperature sensors from the air handling unit manufacturer.
7. Space temperature sensors for non-public spaces shall meet the following additional requirements:

- a. Wall mounted, white protective enclosure. To comply with Campus Standard temperature sensors, occupant adjustment shall be provided. Wall mounted enclosures shall be subject to Owner's approval where installed in public areas.
 - b. The Owner shall select location. No sensor shall be mounted until the Owner gives specific location instructions.
8. Space temperature sensors for all lobbies, public spaces and mullions shall meet the following additional minimum specifications:
- a. Sensor shall be flush mounted button type located as directed by the Owner.
 - b. Shall be protected with a clear cover or use of plate sensor. The Owner shall approve color of sensor.
9. Provide averaging temperature sensors where duct mounted temperature sensors are used to sense mixed air temperature or coil discharge temperature and the cross-sectional area of the duct is 12 square ft. or greater. Averaging temperature sensors shall meet the following requirements:
- a. Copper sheathed construction. Standard conduit box termination. Lead connections shall be rugged.
 - b. Probe shall have a minimum-bending radius of 12 in.
 - c. Probe shall have a minimum immersion length of 12 ft. or a minimum length of one foot per square foot of duct, whichever is greater.
 - d. Probe shall be single continuous sensing RTD or shall be multiple RTD or thermistor sensors spaced no further apart than 6 in.
 - e. Provide suitable supports at all bends and elsewhere as necessary to ensure that the sensor is held firmly in position and will not incur damage from vibration in the air stream. Support shall be provided, at minimum, every 24 in. in addition to support at bends.
10. If required, RTD temperature transducers to be provided having the following minimum specifications:
- a. Input circuit to accept resistance detectors as specified above.
 - b. Output signal of 4-20mA into maximum of 500-ohm load. Output signal shall be proportional to the engineering range detailed in the Point Sheets.
 - c. Output short circuit and open circuit protection.
 - d. Input short circuit and open circuit protection.
 - e. Output variation of less than 0.2% of full-scale output for supply voltage variations of 10%.
 - f. Combined non-linearity, repeatability and hysteresis effects not to exceed 0.5% of full-scale output.

- g. Maximum current to sensor not to exceed manufacturers suggested rating.
- h. Integral, accessible zero and span adjustments.
- i. Long term output drift of equal to or less than 0.50% of full-scale output per year.
- j. Shock and vibration protection as necessary.

B. Control Relays

1. Provide interposing control relays having, at minimum, the following specifications:
 - a. Pickup rating time and hold rating as required for individual applications.
 - b. Input operating voltage to be compatible with the BCS digital output equipment.
 - c. Shock and vibration protection as necessary.
 - d. Rated for a minimum of ten (10 million mechanical operations and a minimum of 500,000 electrical operations.
2. The control relays shall be located in the NCP or other local panels as provided by the BCS Installer.
3. The relays shall provide complete isolation between the motor starter, control circuit and the associated BCS digital output.
4. Select control relays such that they meet the following requirements.
 - a. The malfunction of an NCP/ASC component shall cause the motor to fail on or off or maintain previous status as identified in the Sequences of Operation.
 - b. Following the resumption of power after power interruption to a motor, the motor shall not restart until commanded to do so by the BCS in accordance with a predetermined start-up procedure.
 - c. If a motor is detected by the BCS to have failed, i.e. its BCS monitored and commanded status differ, then the BCS shall shut down the motor and restart shall only be possible (when the HOA switch is in the "Auto") by a manually entered restart command at the BCS.
5. Where hand-off-auto (HOA) switches are provided, the BCS digital output shall be wired such that control of the motor is from the BCS in the auto position only.
6. Other interlocks providing safety control, e.g. shutdown on high temperature/vibration detection, etc., shall not be overridden by the BCS control relays or the installation of the control relays.

C. Thermostats

1. Provide as applicable, line voltage (120 Vac) or, low voltage wall mounted thermostats for equipment as identified on the Mechanical Drawings. Install thermostats as located on the Mechanical Drawings.

2. Each thermostat shall be for single stage with a variable set point 65° to 85°F and shall initially be set up to control space temperature as designated in the sequences of operation.
3. Provide a 3°F dead band.
4. The thermostats shall be complete with bases and sub-bases.
5. The thermostats shall be rated for the application, and shall contain sufficient relay contacts to control valves, fans and dampers.
6. Thermostats controlling equipment in hazardous locations shall meet all applicable codes and requirements regarding the respective hazard.

D. Current Sensing Relays

1. Provide current sensing relays as follows:
 - a. Solid core current transducer.
 - b. Switching range suitable for the application.
 - c. Self-powered transducer.
 - d. Normally open status contacts.
 - e. Hysteresis amperage of no less than 0.2 amps.

E. Fan Inlet Velocity Sensors/ Duct and Plenum Probes

1. Sensors shall be of the thermal dispersion type with true average, independent multi-point sensing capability. Sensors shall be totally constructed from non-corrosive materials, with 304 stainless steel sensor bodies, 304 stainless steel mounting brackets, adjustable cadmium-plated muting rods and “bead in glass” thermistor sensors. Each fan airflow monitoring system shall incorporate at least two sensor probes with four thermistors each.
2. Fan Inlet Performance Requirements – The individual sensor accuracy for airflow shall be better than $\pm 0.15^\circ\text{F}$ ($\pm 0.1^\circ\text{C}$) over the entire operating range.
3. Fan Inlet Sensor Operating Ranges – Airflow: 0 to 10,000 FPM; Temperature: -20°F to $+160^\circ\text{F}$; Relative Humidity: 0 to 99% (non-condensing).
4. Transmitter shall be constructed of an aluminum chassis designed to operate between minus 20°F and 120°F . Transmitter shall be equipped with a 12-bit A/D converter with a minimum reading accuracy of 2%. Transmitter shall output a 4-20 mAdc or 0-10 Vdc signal proportional to air velocity.
5. Approved manufactures and equipment shall include only the following:
 - a. Ebtron Hx Series probes, combination airflow/ temperature sensors with GTX116-F (Duct and Plenum Probe) or GTX108-F (Fan Inlet Sensor) transmitter as appropriate.
 - b. No substitutions.

F. CO2 Sensors

1. Sensors shall be wall-mounted, of the non-dispersive infrared type, for measuring environmental CO2 concentration. Sensors shall measure accurately from 0-2000 ppm. Sensor to be equal to Veris Industries model CWE (for wall-mounted CO2 sensor applications) or Veris Industries model CRLSXX (for duct-mounted CO2 sensor applications) as appropriate.

2.09 AUTOMATIC VALVES - GENERAL

- A. Furnish all valves shown on the Mechanical Drawings and/or described in the sequences of operation as automatic control valves. The Mechanical Installer shall install valves. All other valves such as check valves, relief valves, pressure reducing valves, self-regulating valves, manually operated valves, etc. shall be furnished and installed by the Mechanical Installer. Provide details of the manufacturer's installation requirements to the Mechanical Installer. Refer to the mechanical drawings for the design conditions on which to base sizing and ratings of the valves and their actuators.
- B. All valves shall be in accordance with ANSI B16.10, and ANSI B16.34 as appropriate and all other applicable standards. At minimum, valves shall meet ANSI Class 150 ratings and valves detailed to have minimum working pressure ratings in excess of 150 psig shall, at minimum, meet ANSI Class 300 ratings. Where there is a conflict between ANSI, and other applicable standards, the most stringent shall apply. All valves shall be tested to a minimum of 1.5 times the maximum working pressure rating.
- C. Valves shall have the manufacturer's name and the pressure rating clearly marked on the outside of the body. Where this is not possible manufacturer's name and valve pressure rating shall be engraved on a minimum 2-in. diameter stainless steel tag that shall be attached to the valve by a chain in such a manner that it cannot be unintentionally removed.
- D. Valves up to 2 in. in size shall have screwed ends. Valves 3 in. and larger shall have flanged ends. Flanged valves shall be furnished complete with companion flanges, gaskets and bolting materials. Flanges, gaskets and bolting materials shall meet the requirements of ASME/ANSI B16.3, B16.5, B16.9, B16.11 and all other relevant standards.
- E. Valves shall be suitable for continuous throttling. Control valves shall be selected so that cavitation does not occur over the full operating range of the valve at the system differential pressures. The control valve assembly shall be capable of tight shut-off when operating at system pressure with the system pump operating at shut-off head.
- F. Valve schedules shall be submitted for review and shall clearly show the following for each valve:
 1. Associated system.
 2. Manufacturer and model number.
 3. Size.
 4. Flow rate, flow coefficient – (CV) and pressure drop at design conditions.
 5. Valve configuration (e.g. two way, three way, butterfly).

6. Leakage rate.
7. Maximum pressure shut-off capability.
8. Actuator manufacturer and model number.
9. Valve body pressure and temperature rating.
10. Normally open/closed and failure positions.

G. Control Valves

1. Two-way control valves shall be straight pattern single seat globe type suitable for chilled and hot water service. These valves shall meet the following minimum requirements:
 - a. Modulating design to provide equal percentage flow characteristics.
 - b. Leakage rate shall not exceed 0.01% of the value flow coefficient (CV) at pump shut-off head.
 - c. The valves shall be rated at minimum for the working pressures indicated in the valves schedules.
 - d. Valves shall be suitable for continuous throttling.
 - e. Valve body material shall be cast iron, or carbon steel, with stainless steel trim for working pressures below 300 psig.
 - f. Valve seats shall be metal, ceramic filled PTFE or equivalent and must assure tight seating.
2. Three-way valves shall be suitable for chilled water and hot water service and shall meet the following minimum requirements.
 - a. Modulating design with V-port parabolic or linear plug and stainless steel trim.
 - b. Leakage rate shall not exceed 0.01% of the valve CV from inlet to an outlet port at pump shut-off head when this valve is closed to flow through that outlet port.
 - c. Valve body material shall be cast iron or carbon steel with stainless steel trim.
 - d. Valve seats shall be metal, ceramic filled PTFE or equivalent and must assure tight seating.
3. Pressure drop through modulating control valves shall not exceed 8 psig.

H. Butterfly Valves

1. Butterfly valves shall be the full lug type. Semi-lug valves and wafer valves are not acceptable.
2. The pressure drop across modulating butterfly valves shall not exceed 8 psig. Butterfly valves for isolation service shall be line size and the pressure drop across the valve at maximum design flow shall not exceed 5 psig.

3. The butterfly valve manufacturer shall certify compliance with bubble tight shut-off requirements at a differential pressure not less than the full rated design working pressure and temperature specified with the downstream flange removed with flow in either direction.
 4. Valve body shall be carbon steel, 316 stainless steel, cast iron or ductile iron.
 5. Shaft shall be 316 stainless steel or 17-4PH stainless steel. Guarantee zero leakage to the shaft.
 6. Seat shall be replaceable with a stainless steel, titanium, Inconel or equivalent metal retaining ring. Seat material shall be Teflon (PTFE), reinforced Teflon (RTFE) or resilient elastomer (EPDM).
- I. Valve Actuators
1. All valves shall be provided with electric actuators. Actuators shall be sized to meet the shut-off requirements when operating at the maximum system differential pressure and with the installed system pump operating at shut-off head. Actuators shall control against system maximum working pressures.
 2. All two-way control valves on heating coils shall fail closed upon a loss of power, or as indicated in the Sequences of Operation. The three-way control valves shall fail closed to flow through the coil. Butterfly valves shall fail in the previous position.
 3. Actuators shall have visual mechanical position indication, showing output shaft and valve position. The actuator shall be capable of operating the valve from the fully closed to the fully open position and vice versa in less than two minutes.
 4. Actuators shall be constructed to withstand high shock and vibration without operations failure. The actuator cover shall be die cast aluminum or material of equivalent strength and have captive bolts to eliminate loss of bolts when removing the cover from the base. Materials of construction shall be non-corroding.
 5. Actuators and valves shall be mounted and installed only in the positions approved by the manufacturer. Shop drawings shall clearly indicate the acceptable positions.
 6. Valve actuators shall be of the magnetic or motor driven type. Valve stem position shall be adjustable in increments of one (1) percent or less of full stem travel.
 - a. Motor driven actuators shall have an integral self-locking gear train, mechanical travel stops and two adjustable travel limit switches with electrically isolated contacts; gear assembly shall be made of hardened steel. Motor drive actuators shall be rated for continuous duty and have an input voltage of 120 Vac, 60 Hz. Disassembly of the gears shall not be required to remove the motor. Actuator motor shall be fully accessible for ease of maintenance.
 - b. Magnetic actuators shall be rated for continuous duty and shall have a control signal compatible with the analog output subsystem.

2.10 DAMPERS - GENERAL

- A. Furnish all automatic dampers (AD), as indicated on the Mechanical Drawings. Fusible link dampers for fire protection (FD), smoke dampers (SD) fire smoke dampers (FSD), and manual dampers (MD) for balancing, back draft dampers (BD) and dampers which are specified as part of a factory built air handling unit or terminal unit are not furnished by the BCS Installer. The Mechanical Installer shall install all dampers. Provide details of the manufacturer's installation requirements to the Mechanical Installer.
- B. Provide damper actuators for all dampers that are furnished as part of this Contract. Where practical actuators shall be factory mounted.
- C. Dampers incorporating multiple sections shall be controlled in unison. Where more than one actuator serves a damper, then the actuators shall be driven in unison and the control wiring shall be provided accordingly. Damper sections shall not exceed sixteen (16) square ft. in face area. Damper jackshafts are not acceptable for controlling multiple damper sections.
- D. Dampers incorporating multiple sections shall be designed in such a way that the actuators, whether externally or internally mounted, are accessible without difficulty. Under no circumstances shall it be necessary to remove damper sections, or structural or other fixtures to facilitate removal of damper motors. Provide access doors where necessary to meet this requirement. In particular ensure that where in-air stream actuators are provided they are readily accessible.
- E. For all AD, FSD, and SD that are interlocked to a fan motor(s), the BCS Installer shall wire between the MCC or local starter and the damper actuator. Dampers interlocked to fan motors shall be driven open and spring closed unless otherwise indicated in the Contract Documents. The 120 Vac power supply originating from the MCC or local starter shall be used to power the damper where possible. If the damper is indicated to be spring open and driven closed or requires a separate power source then the BCS Installer shall provide the necessary interposing relays and shall obtain the power supply to hold the damper closed from the nearest available power panel. The BCS Installer shall wire between the AD, FSD or SD position indicator switch, whose contacts shall be rated for a load up to 10 amps at 120 Vac, and the MCC or local starter. The damper position indicator switch contacts shall be closed when the damper is fully open and open when the damper is not fully open. The Fire Alarm System control of interlocked dampers shall be via the fan motor starter.
- F. Automatic Dampers
 - 1. Automatic Dampers (AD) shall be factory fabricated.

2. Damper frames shall be constructed of 16-gauge thick welded galvanized steel channel, or 1/8 in. thick extended aluminum channel. Frames in excess of 3 ft. by 3 ft., shall have corner braces or equivalent means of strengthening to ensure squareness and rigidity. Channel dimensions shall be a minimum of 5 in. by 1 in. Frames shall be constructed for flanged ductwork connection. "Slip-In" (insertion) type dampers shall not be acceptable. Frames shall be sized to match the final dimensions of the ducts including allowance where applicable, for the duct lining materials. Coordinate required installation details with Mechanical Installer. The BCS Installer shall be responsible for coordination of correct sizing for damper assemblies furnished as part of this Contract. Blade stops shall not extend more than 1/2 in. into the air stream.
3. Damper blades shall be constructed of:
 - a. Galvanized sheet steel of minimum 21-gauge thickness with a minimum of four (4) breaks running the entire length of the blade.
 - b. Double galvanized sheet steel of minimum 22-gauge thickness per sheet. Sheets shall be formed with a minimum of four (4) breaks in each sheet running the entire length of the blade. Sheets shall be spot welded together, or
 - c. Airfoil shaped double skin-galvanized steel constructed from minimum 14-gauge thick galvanized sheet steel.
 - d. Airfoil shaped double skin-extruded aluminum constructed from minimum 16-gauge thick sheet.
4. Maximum width for galvanized steel blades shall not exceed 8 in. and for aluminum shall not exceed 6 in. Maximum blade length shall not exceed 48 in.
5. Blade edge seals shall be field replaceable and shall be one of the following:
 - a. Neoprene
 - b. Vinyl
 - c. Polyurethane
 - d. Silicone rubber
 - e. Synthetic elastomer
6. Blade end (side) seals shall be one of the following:
 - a. Continuous spring stainless steel strip
 - b. Synthetic elastomer
 - c. Flexible aluminum compression type.
7. Damper sections shall be installed such that the blades are horizontal.
8. Damper axles shall be constructed of:

- a. Minimum 1/2 in. square zinc plated steel with non-slip between blade and axle.
 - b. Minimum 1/2 in. hexagon zinc plated steel with non-slip locking between blade and axle.
 - c. Minimum 1/2 in. diameter zinc plated steel fastened to the blades with bolts through the axle, rivets or welds to ensure non-slip locking between blade and axle.
9. Damper axle bearings shall be one of the following:
- a. Oil impregnated sintered bronze
 - b. Stainless steel sleeve
10. Linkage that interconnects blades shall be corrosion resistant steel and shall be located on the face of the damper in the air stream or shall be concealed in the frame. Linkages shall be readily accessible for maintenance.
11. Control shaft shall be as specified above and shall extend beyond the frame as necessary to match up with actuator or actuator linkage as applicable.
12. Modulating dampers shall be of the opposed blade type. Two position dampers shall be of either the parallel or opposed blade type.
13. Multiple section dampers shall bolt together to form a rigid structure free from twisting or bending.
14. The two diagonal measurements from upper to lower opposite corners of the installed damper assembly, including multiple section dampers, shall not differ by more than 0.15 in. or 0.2 percent, whichever is greater.
15. The free area ratio, i.e. the open area in a damper assembly, including in-air stream actuators, divided by the total duct area shall not be less than 0.75 for velocities above 1500 fps and 0.6 for velocities below 1500 fps. This shall apply to both single and multiple damper section assemblies.
16. Maximum leakage rate through a 48 in. by 48 in. closed automatic damper shall not exceed 10 CFM per square foot of overall damper face area at 4 in. W.C. pressure differential with a maximum closing torque not exceeding that applied by the actuator provided for the damper. The leakage rate of the field-installed damper shall not exceed the rate specified above. Dampers shall be rated for the maximum air stream face velocity that they will experience during normal operation.
17. Damper schedules shall be submitted for review and shall clearly indicate the following for each damper:
- a. Associated system.
 - b. Manufacturer and model number.
 - c. Mechanical drawing reference.
 - d. Damper size for each section.

- e. Parallel or opposed blade configuration.
 - f. Actuator manufacturer and model number for each section.
 - g. Ratio of anticipated air stream velocity to the manufacturer's maximum recommended velocity rating.
 - h. Free area ratio.
18. If the automatic damper complies with these specifications, one of the following manufacturers will be acceptable:
- a. Greenheck
 - b. Pottorff
 - c. Ruskin
- G. Fire Smoke Damper (FSD)
- 1. Fire Smoke Dampers (FSD) shall be factory fabricated.
 - 2. Damper frames shall be constructed of minimum 16 gauge welded galvanized steel channel. Frames in excess of 36 in. height shall have corner braces or equivalent means of strengthening to ensure squareness and rigidity. Frames shall be constructed for flanged ductwork connection. "Slip In" (insertion) type dampers shall not be acceptable. Frames shall be sized to match the final dimensions of the ducts including allowance where applicable, for the duct lining materials. Coordinate required installation details with Mechanical Installer. BCS Installer shall be responsible for coordination of correct sizing for damper assemblies furnished as part of this Contract. Blade stops shall not extend more than 1/2 in. into the air stream.
 - 3. Damper blades shall be constructed of:
 - a. Galvanized sheet steel of minimum 16 gauges with a minimum of three (3) breaks running the entire length of the blade.
 - b. Airfoil shaped double skin-galvanized steel constructed from minimum 14-gauge sheet.
 - 4. Maximum width for galvanized steel blades shall not exceed six (6) in. Maximum blade length shall not exceed 48 in. for airfoil blades and 36 in. for grooved blade.
 - 5. Blade end (side) seals shall be one of the following:
 - a. Silicone rubber.
 - b. Flexible metal compression type.
 - 6. Damper sections shall be installed such that blades are horizontal.
 - 7. Damper axles shall be constructed of:

- a. Minimum of 1/2 in. square in. zinc plated steel with non-slip between blade and axle.
 - b. Minimum 1/2 in. hexagonal zinc plated steel with non-slip locking between blade and axle.
8. Bearings shall be stainless sleeve type.
 9. Linkage that interconnects blades shall be corrosion resistant steel and shall be concealed in the frame. Linkages shall be readily accessible for maintenance.
 10. Control shaft shall be as specified above and shall be specified above and shall extend beyond the frame as necessary to match up with actuator or actuator linkage as applicable.
 11. Modulating dampers shall be of the opposed type. Two position dampers shall be of either the parallel or opposed blade type.
 12. Modulating dampers shall bolt together to form a rigid structure free from twisting or bending per the manufacturer's approved methods.
 13. Measurements diagonally from upper to lower opposite corners of the installed damper assembly, including multiple section dampers shall not differ by more than 1/8 in. or 0.2%, whichever is greater.
 14. The free ratio, i.e., the open area in a damper assembly divided by the total duct area shall not be less than 0.8. This shall apply to both single and multiple damper section assemblies.
 15. Maximum leakage shall be as for UL 555S Class 1 low-leakage type. Maximum leakage rates shall not exceed the Class 1 UL rating. The FSD shall meet UL555, UL555S, NFPA 90A and NFPA 92A requirements in all respects including size limitations. The FSD shall be one and one half (1 ½) hour fire rated and listed under UL standard 555. The damper and damper actuator shall be furnished as an integral unit and shall be equipped with a UL classified and listed fire stat meeting the elevated temperature qualification of UL 555S at 250°F.
 16. Provide damper position indicator switches that shall be an integral part of the damper actuator or shall be linked directly to the damper blades for indication of the fully open and fully closed position when required by the sequence of operation or the FAS. The damper position indicator switches shall be factory mounted and adjusted by the damper manufacturer. When FSD are associated with a fan these damper position indicator switches shall be hardwire interlocked to inhibit motor start-up. The motor start-up shall be inhibited when the HOT switch is in both the "hand" and "auto" positions. Where damage can result to mechanical components (fans, dampers, etc.). If a damper fails to open prior to fan start-up, then the interlock between the fan and damper shall not be overridden by the fire control system. The BCS Installer shall install the hardwire interlocks.
 17. Dampers shall be rated by the manufacturer for normal operations, for the maximum face velocity that will be imparted by the air stream in which the damper is installed.

18. Damper schedules shall be submitted for review and shall clearly indicate the following for each damper:
 - a. Associated system.
 - b. Manufacturer and model number.
 - c. Mechanical Drawing reference.
 - d. Damper size for each section.
 - e. Parallel or opposed blade configuration.
 - f. Actuator manufacturer and model number for each section.
 - g. Normally open/closed and failure positions.
 - h. Damper end switch interlock.
 - i. High temperature closing devices.
 - j. Ratio of anticipated air stream velocity to the manufacturer's maximum recommended velocity rating.
19. If the FSD complies with these specifications, one of the following manufacturers will be acceptable:
 - a. Ruskin
 - b. Pottorff
 - c. Greenheck

2.11 DAMPER ACTUATOR

A. Damper Actuators.

1. Provide damper actuators for all automatic control dampers, including those furnished as part of a packaged air-handling unit.
2. Electric damper actuators used for two-position service shall be of the spring return type. Modulating dampers shall be motorized in both directions with spring return to the failure (de-energized) position. Unless stated otherwise in these Contract Documents dampers shall fail to the closed position on loss of power. Damper actuators shall have a service life, at minimum, of 60,000 fully closed to fully open to fully closed operations. In addition the modulating damper actuators shall have a service life of, at minimum, 1000 spring operations on loss of power.
3. Actuators shall stroke by the rotating motion of a reversible, overload-protected synchronous motor or shall be direct-coupled rotary type actuators.

4. The actuators shall be protected against overload by an integral magnetic clutch that shall allow the motor to continue running when, for example, the actuator is stalled at the end of its stroke or by a jammed damper. Alternatively, stall protection shall be by non-overloading impedance protected motor.
5. Provide sufficient quantity of additional damper actuators to meet the damper leakage requirements for the installed damper assembly. At minimum the torque provided shall be such as to meet the maximum close-off leakage requirements.
6. Provide mounting brackets suitable for extended shaft mounting or direct damper drive shaft mounting. The actuator housing shall be rugged and non-corrosive.
7. Damper actuator shall be fully accessible for ease of maintenance. Shop drawings shall clearly indicate motor locations on multiple section damper assemblies.
8. The actuators shall stroke two position dampers from fully closed to fully open in less than two (2) minutes. Modulating dampers shall be driven from fully closed to fully open and vice versa in less than two (2) minutes. This time shall not include the initial period following the availability of power, not to exceed 200 seconds, which is required to tension the spring.
9. The control signal to the modulating damper actuators shall be compatible with the BCS analog output subsystem e.g. 4-20 mA, 0 to 10 Vdc, etc.
10. Actuators shall be as manufactured by Belimo.

2.12 SMOKE DETECTORS

- A. The contractor shall for each air handling system with 2000 CFM (nominal 5 Tons) or greater airflow, install UL-listed ionized smoke detectors in the main supply air duct and main return air duct and/or where shown on the drawing. Smoke detectors furnished by Division 26. Refer to Section 23 0512. Connect the detectors into the control circuit to stop the fan in the event of the presence of smoke.
 1. System airflow included the total airflow of all units serving any single space and all units connected to the same return air plenum.

PART 3 - EXECUTION

3.01 GENERAL

- A. All grounding, wiring, selection of components and installations shall conform to the National Electrical Code with amendments to the date of issue of this specification.
- B. The installation shall conform to each manufacturer's recommended procedures and to all applicable codes, statutes and ordinances and to the Contract Documents. In each and every instance of application, the code, regulation, statute, by-law or specification having the most stringent requirements shall apply.
- C. All installations to be performed by skilled and certified technicians.

- D. All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Provide anti-vibration mounts, if required, for the proper isolation of the equipment.
- E. Install equipment so as to allow for easy maintenance access. Install equipment such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.
- F. Install equipment in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensate traps.
- G. All components placed in areas of high humidity or potentially high humidity must be adequately protected.
- H. The Contractor shall for each handling system with 2000 CFM airflow (nominal 5 Tons) or greater, install UL listed ionization smoke detectors in the main return air duct, and/or where shown on the drawings. Smoke detectors may be omitted from the main supply air duct when explicitly not required by local code. Smoke detectors furnished by Division 26. Refer to Section 23 0512. Connect the detectors into the control circuit to stop the fan in the event of the presence of smoke.
 - 1. System airflow includes the total airflow of all units serving any single space and all units connected to the same return air plenum.

3.02 CONDUIT, WIRING, CABLING AND FITTINGS

- A. The installation shall conform to the Division 23 and 26 Contract Documents for this project.
- B. All wires and cables for powering the BCS as provided shall be:
 - 1. Ninety-eight (98) percent conductivity copper.
 - 2. A minimum of #12 AWG for branch 120 VAC power circuits.
 - 3. A minimum of #14 AWG for DO motor control circuits.
 - 4. A minimum of #20 AWG for sensing, transmitter, DO (except motor control circuits) and AO control circuits. Where manufacturers recommend a heavier conductor, then the BCS Installer shall comply with the manufacturer's recommendation.
 - 5. A minimum of #20 AWG for communication trunk, shielded and grounded at a single end.
 - 6. Stranded copper conductors throughout for #18 AWG and smaller diameter wire.
- C. All cabling shall be plenum rated cable and shall be as specified above with the following additional requirements:
 - 1. All plenum rated wire and cable shall be a minimum of #20 AWG and shall be shielded.
 - 2. Cable jacket shall have a minimum thickness of 0.015 in. and shall be bright orange, red, yellow or other bright, distinctive color. Coordinate jacket color with other trades.

3. Plenum wiring and cabling shall be routed through cable rings or hooks. Cable rings and hooks shall be suitably spaced to properly support plenum cabling and shall be attached to ductwork hangers or structure as applicable.
- D. Smaller gauge wiring shall be acceptable if certified by the equipment manufacturer. If complications arise, however, due to wiring size, replace the wire at no additional cost to the Owner.
- E. The sizing and provision of wire for the main BCS trunk wiring are the design responsibility of the BCS Installer.
- F. Obtain and pay for all electrical inspection fees related to the work of this section.
- G. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
 1. All circuits are continuous and free from short circuits and grounds.
 2. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megohms.
- H. Provide complete testing for all wiring installed or utilized as part of this work. Provide all equipment, tools, and personnel as necessary to conduct these tests.
- I. Provide complete grounding of all power and signal wiring so as to ensure system integrity of operation.
- J. NCP/ASC shall not be mounted in-line with vertical conduit but shall be connected off to the side of the vertical conduit by suitably pitched conduit such that any condensed moisture in the vertical conduit cannot enter the NCP/ASC enclosures.
- K. Non-shielded wiring may only be provided upon certification from the manufacturer that non-shielded wiring will not cause degradation of system performance and will not render the system more susceptible to damage. However, if complications arise from the use of non-shielded wiring, replace the wiring at no additional cost to the Owner.
- L. BCS wiring shall not run in the same conduit as power wiring of 120 V voltage or higher.
- M. Suitably coated wire may be used in ceiling spaces and in tenant wall partitions without conduit where local codes permit and the cable jacks and insulation have been accepted under the provisions of the National Electrical Code and have been classified by UL, Inc. For use without conduit in air plenums. Elsewhere use Electrical Metallic Tubing (EMT).
- N. Sleeves shall be provided by the BCS Installer where required and shall meet the requirements detailed in the Division 26 Contract Documents for this project.
- O. All wiring shall be marked in accordance with the National Electrical Code. Provide the labeling of wire at every termination. Each wire shall be identified which uniquely identifies each wire and which corresponds to the shop Drawings and as-built Drawings provided under this Contract.

3.03 EQUIPMENT, INSTALLATION

- A. Temperature sensing wells.
 - 1. Provide list with shop drawing of well locations to Mechanical Installer.
- B. Locate temperature sensors, humidity sensors, thermostats, and humidistat for room control immediately as shown on the mechanical drawings. Prior to installation, coordinate sensor and/or thermostat locations with the Owner and Architect.
 - 1. Prior to installation, coordinate sensor and/or thermostat locations with Owner's Representative.
- C. Mount local control panels on at convenient locations adjacent to equipment served.
 - 1. Tag each instrument corresponding to symbols used on control diagrams.
- D. Furnish all control valves (globe and butterfly, as applicable) to the Mechanical Installer. Mechanical Installer to install control valves per the valve manufacturer's recommendations.

3.04 COMMISSIONING

- A. BCS shall be installed and commissioned by factory-trained technicians skilled in the setting and adjustment of BCS equipment used in this project. This technician is to be experienced in the type of systems associated with this BCS,
- B. Perform a complete and detailed calibration and operational check for each individual point and for each individual function as contained within the BCS. These checks shall ensure that all equipment, software, network elements, modules and circuits as provided under the terms of this contract are functioning as per the Contract Documents. Such checks shall be carried out with the use of point/function log sheets. Point/function sheets are to be prepared by the Contactor and submitted to the Engineer for the approval of content and format. Such calibration and operation checks shall be performed prior to the commencement of final tests on completion for any relevant system part. The point/function logs shall, at minimum, include the following:
 - 1. Identification of each point by BCS point name and expanded descriptor.
 - 2. Indication of BCS value/status, field-tested value/status, and deviation between the BCS and field-tested value/status.
 - 3. Confirmation of system safeties operation.
 - 4. Confirmation of proper failure modes of motors, dampers, valves, etc.
 - 5. Confirmation of proper tuning of PID control loops.
 - 6. Confirmation of proper sequence of operation performance.
 - 7. Manufacturer, model number and accuracy of test instruments used.
 - 8. Date of testing/verification and name of individuals performing the tests.

- C. At time of final observation, demonstrate the sequence of operation for each system to the Owner and Engineer. Perform system demonstration as directed by Owner and Engineer.

3.05 TRAINING

- A. Provide a minimum of 4 hours of instructions to Owner's personnel in the operation and maintenance of the control system. Provide training after the system has been installed and commissioned. Training shall be on-site, using the installed BCS as the basis for training. Provide Training Manuals and O&M Manuals for students attending on-site training.

3.06 WARRANTY

- A. At completion of final test of installation and acceptance by Owner, provide any service incidental to proper performance for a period of one year.
- B. Equipment shall be warranted for one year (including defects in workmanship and material) under normal use and service. During warranty period supplier shall also replace or repair, free of charge, any equipment proven to be defective in workmanship or material.
- C. Certain electronic devices not manufactured by the BCS supplier such as computers, etc., shall carry the original manufacturer's warranty. Pass any registration and warranty documents and warranty rights to the Owner.
- D. All software upgrades, enhancements or revisions that are initiated by the BCS manufacturer up to the time of expiration of the warranty period shall be provided at no additional cost to the Owner.

END OF SECTION

**SECTION 23 2113.23
HYDRONIC PIPING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of hydronic piping work is indicated on drawings and schedules, and requirements of this section.
- B. This section includes pipe, fittings, and valves for hydronic piping systems installed in the project as follows:
 - 1. Heating Water.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hydronic piping products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with hydronic piping work similar to that required for project.
- C. Codes and Standards:
 - 1. ASME Compliance: Fabricate and install hydronic piping in accordance with ASME B31.9 "Building Services Piping".
 - 2. UMC Compliance: Fabricate and install hydronic piping in accordance with ICBO "Uniform Mechanical Code".
 - 3. IMC Compliance: Fabricate and install hydronic piping in accordance with "International Mechanical Code."

1.03 SUBMITTALS

- A. Provide the following submittals in accordance with Division 01 and Section 23 0010.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for hydronic piping materials and products.
- C. Shop Drawings: Submit scaled layout Drawings of hydronic piping and fittings including, but not necessarily limited to, pipe and tube sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment.
- D. Submit certificates as listed below:
 - 1. Test Certificates of Approval for Piping Systems.
- E. Record Drawings: At project closeout, submit Record Drawings of installed hydronic piping and piping products, in accordance with requirements of Division 01.

- F. Maintenance Data: Submit maintenance data and parts lists for hydronic piping materials and products. Include this data, product data, shop drawings, and record Drawings in maintenance manual; in accordance with requirements of Division 01.

1.04 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

PART 2 - PRODUCTS

2.01 PIPING AND FITTINGS - GENERAL

- A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements.
- B. Provide materials and products complying with ASME B31.9 Code for Building Services Piping where applicable, base pressure rating on hydronic piping systems maximum design pressures.
- C. Provide sizes and types as required to match piping and equipment connections; provide fittings of materials which match pipe materials used in hydronic piping systems.
- D. Where more than one type of material or product is indicated, selection is Installer's option.

2.02 BASIC PIPES AND PIPE FITTINGS

- A. Hydronic Piping:
 - 1. Pipe Size 2 in. and Smaller: ASTM A53 black steel pipe; Schedule 80; ASTM A126 Fittings Class 125 cast-iron with ANSI B16.4 threaded joints.
 - 2. Tube Size 3 in. and Smaller: ASTM B88 copper tube; Type L, hard-drawn temper; wrought-copper fittings, ANSI/ASME B16.27 with soldered joints, ANSI/ASTM B32, Grade 95TA.
 - 3. Pipe Size 2-1/2 in. and Larger: ASTM A53 black steel pipe; Schedule 40; wrought-steel butt welding standard weight fittings, ASTM A234 and ANSI/ASME B16.9 with welded joints, ANSI/ASME B16.25.
 - 4. Pipe Size 2-1/2 in. and Larger: Black steel pipe; Schedule 40, ASTM A53 grooved fittings with mechanical grooved couplings. Stainless steel nuts and bolts shall be used to secure grooved piping systems.

2.03 FLANGES, UNIONS AND COUPLINGS

- A. Pipe Size 2 in. and under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints. Bolt standard for flange connections: ASTM A193 grade B7: Alloy Steel, AISI 4140/4142.
- B. Pipe Size Over 2 in.: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; gaskets suitable for intended service – NO ASBESTOS GASKET MATERIAL ALLOWED. Bolt standard for flange connections: ASTM A193 grade B7: Alloy Steel, AISI 4140/4142.

- C. Grooved and Shouldered Pipe End Couplings: Malleable iron housing clamps to engage and lock, designed to permit some angular deflection, contraction and expansion; "C" shape composition sealing gasket; steel bolts, nuts, and washers; galvanized couplings for galvanized pipe.
 - 1. Acceptable Manufacturers:
 - a. Apollo Shurjoint
 - b. Gruvlok (Anvil International)
 - c. Tyco (Grinnell Mechanical Products)
 - d. Victaulic
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, and water impervious isolation barrier.

2.04 BASIC VALVES

- A. Ball Valves: For shutoff and throttling.
 - 1. Ball valves 2 in. and less: MSS SP-72, rated for 200 psig minimum water pressure, full port, forged bronze or stainless steel body, 316 or 304 stainless steel ball and stem, reinforced Teflon seats and seals, threaded or soldered connections. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).
 - a. Acceptable Manufacturers and Models:
 - 1) Apollo 77-100 Series
 - 2) Jomar T-100-SS
 - 3) KITZ 68M
 - 4) Nibco T-585-70-66
 - 5) Victaulic Series 722
 - 6) Watts B-6080, B-6081
- B. Butterfly Valves: For shutoff and throttling.
 - 1. Butterfly valves 2-1/2 in. and larger: MSS SP-67, rated for 200 psig minimum water pressure, full lug style with threaded connections (rated for dead end service), iron body, stainless steel stem, EPDM seat material, gear operator with wheel, for flanged connections. Butterfly valves shall be resilient seated with bronze or stainless steel discs and shall be bubble-tight. Throttling valves shall be provided with memory stops (for establishing any setpoint from 0-100% flow).
 - a. Acceptable Manufacturers and Models:
 - 1) Apollo LD141

- 2) Crane 42
- 3) Jomar 600/900
- 4) KITZ 6123E, 6121E
- 5) LD-2000-3 (Lever operated)
- 6) LD-2000-5 (8" and above gear operated)
- 7) Milwaukee ML Series
- 8) Stockham LG-522
- 9) Victaulic Vic-300 MasterSeal
- 10) Watts BF-03

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which hydronic piping systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Prior to and during the installation of grooved piping systems, the grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and the installation of all grooved-end products. The manufacturer's representative shall periodically visit the jobsite to review and inspect installations. Contractor shall remove and replace any joints deemed improperly installed. All grooving tools and products shall be of the same manufacturer.

3.02 INSTALLATION OF HYDRONIC PIPING

- A. General: Install hydronic piping in accordance with the following requirements:
 1. Install eccentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.
 2. Install piping with 1/32 in. per ft. (1/4%) upward slope in direction of flow.
 3. Connect branch-feed piping to mains at horizontal centerline of mains; connect run-out piping to branches at horizontal centerline of branches.
 4. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
 5. Install dielectric connections wherever joining dissimilar metals.

3.03 INSTALLATION OF VALVES

- A. Provide ball or butterfly valves for shutoff service as follows:

1. On each branch riser, close to main, where branch or riser serves 2 or more hydronic terminals or equipment connections, and elsewhere as indicated.
 2. On inlet and outlet of each mechanical equipment item, and on inlet of each hydronic terminal, and elsewhere as indicated.
 3. As drain valves on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic system.
- B. Provide ball or butterfly valves for throttling service as follows:
1. On outlet of each hydronic terminal, and elsewhere as indicated.
- C. Valves shall be labeled on ceiling grid or any access panel for location verification.

3.04 EQUIPMENT CONNECTIONS

- A. General: Connect hydronic piping system to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.
- B. Hydronic Terminals: Install hydronic terminals with hydronic terminal outlet valve and union on outlet; union, shutoff valve on inlet. Install manual air vent valve on element in accordance with manufacturer's instructions. Locate valves and balancing cocks behind valve access doors for ease of maintenance. Where indicated, install automatic temperature control valve with unions between gate valve and element on supply line.

3.05 TESTING

- A. General: Furnish pumps, gauges, equipment, and personnel required, and test as necessary to demonstrate the integrity of the furnished installation.
- B. Pressure Piping: Hydrostatically test and make tight at 1-1/2 times the normal operating pressure and not less than 150 psig. Repair leaking joints and retest.
- C. Gravity Piping: Unless otherwise directed, plug all openings and fill with water to a height equal to highest connected equipment. Allow to stand one hour. Remake leaking joints and retest.
- D. Tests and Test Procedures shall be witnessed and approved by the Architect.
- E. After completion and approval of testing, submit "Test Certificates of Approval" for heating water piping systems stating that all test results are satisfactory. Certificates of Approval must be signed by Contractor and Architect.

3.06 CLEANING

- A. Cleaning, Flushing and Inspecting: Flush hydronic piping with potable water until the system can operate for eight (8) hours without partial build-up in strainers.

- B. Chemical Treatment: Refill hydronic piping systems, adding caustic soda to maintain pH of 8.0 to 8.5 and sodium sulfate in amount of 1/3 caustic soda or to maintain residual of 30- to 40-ppm in system. Add trisodium phosphate to make hardness of 0-ppm and residual of approximately 30-ppm in system. Repeat measurements daily with system under full circulation and apply chemicals to adjust levels until no change is apparent.
 - 1. Coordinate chemical treatment of the hydronic systems after installation of new piping and filling/re-filling of system with the Owner's Water Treatment Supplier. The additional chemicals required due to cleaning and filling/re-filling of the hydronic systems are a part of this project, and the responsibility of the Contractor.

3.07 TESTING, ADJUSTING AND BALANCING

- A. Test, adjust and balance hydronic systems in accordance with requirements of Section 23 0593.

END OF SECTION

**SECTION 23 2113.24
HYDRONIC SPECIALTIES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of hydronic specialties required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of hydronic specialties specified in this section include the following:
 - 1. Balance Valves.
 - 2. Balance Cocks.
 - 3. Vent Valves.
- C. Hydronic specialties furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for insulation of hydronic specialties; not work of this section.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of hydronic specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Hydronic Specialty Types: Provide hydronic specialties of same type by same manufacturer.
- C. Codes and Standards:
 - 1. ASME Compliance: Manufacture and install hydronic specialties in accordance with ASME B31.9 "Building Services Piping".
 - 2. UL and NEMA Compliance: Provide electrical components of hydronic specialties that are listed and labeled by UL, and comply with NEMA standards.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of hydronic specialty. Include pressure drop curve or chart for each type and size of hydronic specialty. Submit schedule indicating manufacturer's figure number, size, location, rated capacities, and features for each required hydronic specialty.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of hydronic specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 HYDRONIC SPECIALTIES

- A. General: Provide factory-fabricated hydronic specialties recommended by manufacturer for use in service indicated. Provide hydronic specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option, but more than one type cannot be used on project.

2.02 BALANCE VALVES

- A. General: Provide balance valves as indicated, of one of the following types:
1. Threaded Ends 2 in. and Smaller: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, draining kit, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature, from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Connection in NPT threads from ½" to 2". Made of dezincification resistant copper alloy. Handwheel shall have at least 400 different adjustments positions. Pressure class of 290 psi. Working temperature range -4°F to 248°F.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 78K, Series 787
 - 2) Nibco T-1810
 2. Soldered Ends 2 in. and Smaller: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, draining kit, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature, from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Connection in NPT threads from ½" to 2". Made of dezincification resistant copper alloy. Handwheel shall have at least 400 different adjustments positions. Pressure class of 290 psi. Working temperature range -4°F to 248°F. IMI-TA/Victaulic Series 786 or approved equal.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 786
 - 2) Nibco T-1810

3. Grooved Ends 2-1/2 in. and Larger: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Grooved connection from 2 1/2" to 12". Valve body made in ductile iron, bonnet restriction cone and spindle made of dezincification resistant brass alloy. Handwheel shall have 160-440 different adjustments positions depending on valve size. Pressure class ANSI 150#. Working temperature range -4°F to 248°F.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 789
 - 2) Approved equal

4. Flanged Ends 2-1/2 in. and Larger: Multi-Turn Y Pattern Globe Style Balancing valve with shut-off function, adjustments by a digital read-out Handwheel with a lock position feature, measuring of flow, differential pressure, and temperature from two self-sealing measuring ports. Manufacturer shall provide flow measuring station if not integral within valve body via PT ports. Connection in ANSI flanges from 2 1/2" to 16". Valve body made in ductile iron, bonnet restriction cone and spindle made of dezincification resistant brass alloy. Handwheel shall have 160-440 different adjustments positions depending on valve size. Pressure class ANSI 150#. Working temperature range -4°F to 248°F. IMI-TA/Victaulic Series 788 or approved equal.
 - a. Acceptable Manufacturers / Models:
 - 1) IMI-TA/Victaulic Series 788
 - 2) Approved equal

2.03 VENT VALVES

- A. Manual Vent Valves: Provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8 in. NPS connection.
- B. Automatic Vent Valves: Provide automatic vent valves designed to vent automatically with float principle, stainless steel float and mechanisms, cast-iron body, pressure rated for 125 psi, 1/2 in. NPS inlet and outlet connections.
- C. Manufacturer: Subject to compliance with requirements, provide vent valves of one of the following:
 1. Armstrong Machine Works.
 2. Bell & Gossett ITT; Fluid Handling Div.
 3. Hoffman Specialty ITT; Fluid Handling Div.
 4. Spirax Sarco.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which hydronic specialties are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF HYDRONIC SPECIALTIES

- A. Balance Valves: At Installer's option, install balance valves in lieu of terminal outlet valves and balance cocks. Install on each hydronic terminal and elsewhere as indicated. After hydronic system balancing has been completed, mark each balance valve with stripe of yellow lacquer across body and stop plate to permanently mark final balanced position.
- B. Balance Cocks: Install balance cocks on outlet of each hydronic terminal, on end of each hydronic zone circuit, on discharge of each hydronic pump, and elsewhere as indicated. After hydronic system balancing has been completed, mark each balance cock with stripe of yellow lacquer across body and stem to permanently mark final balanced position.
- C. Vent Valves:
 - 1. Manual Vent Valves: Install manual vent valves on each hydronic terminal at highest point, and on each hydronic-piping drop in direction of flow for mains, branches, and run outs, and elsewhere as indicated.
 - 2. Automatic Vent Valves: Install automatic vent valves at top of each hydronic riser and elsewhere as indicated. Install shutoff valve between riser and vent valve, pipe outlet to suitable plumbing drain, or as indicated.

END OF SECTION

**SECTION 23 3113.19
DUCTWORK ACCESSORIES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this section.
- B. Types of ductwork accessories required for project include the following:
 - 1. Dampers.
 - a. Low-pressure manual dampers.
 - 2. Turning vanes.
 - 3. Duct hardware.
 - 4. Duct access doors.
 - 5. Flexible connections.
 - 6. Concealed Damper Regulators.
- C. Refer to other Division 23 sections for testing, adjusting, and balancing of ductwork accessories; not work of this section.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Codes and Standards:
 - 1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible," 2005 edition.
 - 2. Industry Standards: Comply with latest ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
 - 3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers."
 - 4. NFPA Compliance: Comply with applicable provisions of NFPA 90A latest edition "Installation of Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.
- B. Shop Drawings: Submit manufacturer's assembly type Shop Drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.
- C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and Shop Drawings in maintenance manual; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 DAMPERS

- A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards."
- B. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:
 - 1. Air Balance, Inc.
 - 2. Nailor
 - 3. American Warming & Ventilating, Inc.
 - 4. Louvers & Dampers, Inc.
 - 5. Penn Ventilator Co.
 - 6. Ruskin Mfg. Co.
 - 7. Pottorff

2.02 TURNING VANES

- A. Fabricated Turning Vanes: Provide fabricated turning vanes and vane runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards".
- B. Turning Vanes: Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Tab spacing shall be SMACNA standard. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert tabs that align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs when fastened per the manufacturer's instructions.
- C. Acoustic Turning Vanes: Provide acoustic turning vanes constructed of air-foil shaped aluminum extrusions with perforated faces and fiberglass fill.

- D. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:
1. Aero Dyne Co.
 2. Anemostat Products Div.; Dynamics Corp. Of America
 3. Barber-Colman Co.
 4. Ductmate Industries, Inc.
 5. Duro Dyne Corp.
 6. Hart & Cooley Mfg. Co.
 7. Register & Grille Mfg. Co., Inc.

2.03 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
 2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12 in. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
- B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:
1. Ventfabrics, Inc.
 2. Young Regulator Co.

2.04 DUCT ACCESS DOORS

- A. General: Provide where indicated, duct access doors of size indicated.
- B. Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12 in. high and smaller, 2 handle-type latches for larger doors.
- C. As an option, clamping type access doors may be installed.
- D. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:
1. Air Balance Inc.
 2. Ductmate Industries, Inc.

3. Duro Dyne Corp.
4. Register & Grille Mfg. Co., Inc.
5. Ruskin Mfg. Co.
6. Ventfabrics, Inc.
7. Zurn Industries, Inc; Air Systems Div.

2.05 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibrating equipment. Construct flexible connections of neoprene coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.
- B. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:
 1. American/Elgen Co.,; Energy Div.
 2. Ductmate Industries
 3. Duro Dyne Corp.
 4. Flexaust (The) Co.
 5. Ventfabrics, Inc.

2.06 CONCEALED DAMPER REGULATORS: FOR VOLUME DAMPERS LOCATED ABOVE GYP BOARD, PLASTER OR OTHER HARD CEILINGS:

- A. Concealed damper regulators shall be designed to control volume dampers from the ceiling line. Regulators shall be imbedded so the entire unit is flush with the finished surface. The regulator cover plate shall cover the joint between the box and the ceiling. The cover shall be adjustable from 1/2 in. to 1-1/8 in. utilizing the manufacturer's spanner wrench. Coverplate to have zinc plated finish, suitable for painting. Concealed damper regulators to be Young Regulator Model 315.
- B. Volume dampers for concealed damper regulators shall be Young Regulator Model 5020-B (round) or Model 820A-C (rectangular), designed and installed for operation by ceiling mounted regulators.
- C. Where required, provide Young Regulator Model 927 Right Angle Miter Gears, or Model 1200 Right Angle Worm Gear Regulator, to allow control of a damper that has the damper shaft perpendicular to the shaft from the ceiling mounted damper regulator.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90° elbows in supply, return and exhaust air systems, and elsewhere as indicated.
- C. Install manual balancing dampers for branch ducts and individual runout ducts as close to the main duct as possible.
- D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Duct access doors shall be provided on the entering air side of all dampers and turning vanes. Access doors/panels shall be large enough to allow for maintenance of HVAC device. Size shall be coordinated with UNT Facilities Maintenance.
- E. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.03 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

3.04 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
 - 1. Label access doors in accordance with Division 23 Section "MECHANICAL IDENTIFICATION".
 - 2. Final positioning of manual dampers is specified in Division 23 Section "MECHANICAL TESTING, ADJUSTING AND BALANCING".
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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**SECTION 23 3113
METAL DUCTWORK**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.
- B. All duct dimensions shown on drawings are net inside clear dimensions.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with metal ductwork systems similar to that required for project.
- C. Codes and Standards:
 - 1. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible", First Edition, 2005, for fabrication and installation of metal ductwork.
 - 2. ASHRAE Standards: Comply with ASHRAE Handbook latest edition, HVAC Systems and Equipment volume, Chapter 16 "Duct Construction", for fabrication and installation of metal ductwork.
 - 3. NFPA Compliance: Comply with latest editions of NFPA 90A "Installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Installation of Warm Air Heating and Air Conditioning Systems".
- D. Field Reference Manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
- E. Flame/Smoke Ratings: Provide composite mechanical system (insulating material, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
- F. All adhesives, sealants and sealant primers shall contain low VOC (Volatile Organic Compounds), as outlined in the South Coast Air Quality Management District (SCAQMD) Rule #1168.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for metal ductwork materials and products.

- B. Shop Drawings: Submit scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials and rigidity are not reduced.
- C. Record Drawings: At project closeout, submit record drawings of installed metal ductwork and ductwork products, in accordance with requirements of Division 01.
- D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division 01.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials that are free from visual imperfections including pitting, seam marks, roller marks, and stains and discolorations, and other imperfections, including those that would impair painting.
- B. Sheet Metal: All interior ducts shall be constructed with G-60 or better galvanized steel (ASTM A 653/A 653M) LFQ, chem treat. Exterior ductwork or duct exposed to high humidity conditions (i.e. moisture laden exhausts not specified to be stainless steel) shall be G-90 or better galvanized steel LFQ, chem treat.
- C. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A167; Type 302, 304, or 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.
- D. Aluminum Sheet: Where indicated, provide aluminum sheet complying with ASTM B209, Alloy 3003, Temper H14.
- E. Copper Sheet: Where indicated, provide copper sheet complying with ASTM B370; H00 temper, except where 060 temper is required for unusual forming.

2.02 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15° change of direction per section. Unless specifically detailed otherwise, use 45° laterals and 45° elbows for branch takeoff connections. Where 90° branches are indicated, provide conical type tees.
- C. Duct Sealant:
 - 1. Duct sealer shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall seal out water, air, and moisture. Sealer shall be UL listed and conform to ASTM E 84.
 - 2. Comply with requirements of SMACNA Table 1-2.
 - 3. Manufacturers:
 - a. Benjamin-Foster
 - b. Ductmate - PROseal.
 - c. Duro Dyne S2.
 - d. Hardcast.
 - e. United Sheet Metal.
- D. Duct Cement:
 - 1. Non-hardening, non-migrating mastic or liquid elastic sealant of type applicable for fabrication/installation detail as compounded and recommended by manufacturer specifically for cementing fitting components, or longitudinal seams in ductwork.
 - 2. Comply with requirements of SMACNA Table 1-2.
 - 3. Manufacturers:
 - a. Benjamin-Foster.
 - b. Duro Dyne S2.
 - c. Hardcast.
 - d. United Sheet Metal.
- E. Ductwork Support Materials:
 - 1. General:
 - a. Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

- b. Comply with applicable provisions of SMACNA 2005 Standards, Figures 4-1 through 4-8, and Tables 4-1 through 4-3.
2. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4 in. diameter or 3/16 in. thickness may be plain (not galvanized).
3. For exposed stainless steel ductwork, provide matching stainless steel support materials. For copper ductwork, provide copper, bronze or brass support materials.
4. For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.

2.03 FLEXIBLE DUCTS

A. General:

1. Spiral wound spring steel with flameproof metallized polyester sheathing, complying with UL181.
2. Comply with applicable provisions of SMACNA 2005 Standards, pages 3-13 through 3-20.
3. Installation shall conform to conditions under which UL listing was granted.
4. Flexible Ductwork runouts shall be limited to 6' - 0" extended length.

B. Insulation:

1. Insulate all flexible ducts, both supply and return, with a minimum R-Value of 6.0, per International Energy Conservation Code – latest edition. Duct shall have a continuous flexible fiberglass sheath with UL approved metallized polyester barrier jacket.

C. Flexible Ductwork shall be equal to ATCO #036

D. Manufacturers: Subject to compliance with requirements, provide flexible ducts manufactured by one of the following:

1. ATCO.
2. Thermaflex.
3. Quietflex.

2.04 FABRICATION

- A. Shop-fabricate ductwork in 4,8,10, or 12 ft. lengths, unless otherwise indicated or required to complete runs. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match mark sections for reassembly and coordinated installation.
- B. All duct dimensions shown on drawings are net inside clear dimensions.
- C. Shop-fabricate ductwork of gauges and reinforcement complying with SMACNA 2005 Standards as follows:

1. Rectangular, Steel:
 - a. Tables 1-1 through 1-13.
 - b. Figures 1-2 through 1-18.
 - c. Fittings and Construction, Section II.
 2. Rectangular, aluminum: Pages 1-31 through 1-33.
 3. Round, Oval and Flexible Duct: Section III.
- D. Shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Handbook, HVAC Systems and Equipment Volume, Chapter 16 "Duct Construction".
- E. Longitudinal Seams: Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.
- F. Ductmate or W.D.C.I. proprietary duct connection systems will be acceptable. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- G. Formed on flanges (T.D.C./T.D.F./T-25A/T-25B) will only be acceptable when submitted for approval prior to installation of any ductwork. Formed on flanges will be constructed as SMACNA T-25 flanges, whose limits are defined on Page 1.36 of the 2005 SMACNA Manual, First Edition. No other construction pertaining to form on flanges will be acceptable. Formed on flanges shall be acceptable for use on ductwork 42 in. wide or less, with 2 in. positive pressure static or less, and must include the use of corners, bolts and cleat.
- H. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30° for contracting tapers and 20° for expanding tapers.
- I. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 23 Section "Ductwork Accessories" for accessory requirements.
- J. Round Duct Joints:
1. 0 in. - 20 in. diameter, interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3 in. wide duct tape.
 2. 21 in. - 72 in. diameter, use 3 piece, gasketed, flanged joints consisting of 2 internal flanges (with integral mastic sealant) split to accommodate minor differences in duct diameter, and one external closure band designed to compress gasketing between internal flanges. Example: Ductmate Spiralmate or equal.
 3. 73 in. diameter and up, use companion angle flanged joints only as defined on page 3-6 of the SMACNA Manual. Refer to manual for proper sizing and construction details.
Ductwall to be welded longitudinal seams.

K. Pressure Classifications:

1. Static pressure ratings for ductwork systems shall be as noted on the drawings, and/or shall conform to requirements of 2005 SMACNA Standards, Table 1-1.
2. In no case shall the pressure rating of the duct be less than that indicated in Table 1-1 for the apparent duct velocity.
3. Gauges of metal and reinforcing methods shall conform to SMACNA requirements as follows:
 - a. Rectangular Steel: Table 1-3 through 1-13.
 - b. Rectangular Aluminum: Tables 1-14 through 1-16.
 - c. Round, or Flat Oval, Steel: Table 3-2.
 - d. Round Aluminum: Table 3-3.

2.05 FACTORY-FABRICATED DUCTWORK

- A. At Contractor's option, factory-fabricated ductwork sections, fittings, etc., may be substituted for shop-made items.
- B. Factory-fabricated items shall comply in every respect with SMACNA requirements listed previously in this Section, or show proof from a recognized, approved independent laboratory, prior to bidding, that the proposed construction methods produce products that equal, or exceed, the SMACNA 2005 Standards.
- C. Comply with applicable provisions of International Mechanical Code and local amendments.
- D. Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork and/or fittings of one of the following:
 1. Ductmate, Inc., Monongahela, PA.
 2. Semco Mfg., Inc.
 3. United Sheet Metal Div., United McGill, Inc.

PART 3 - EXECUTION

3.01 INSPECTION

- A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF METAL DUCTWORK

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (3% leakage for systems rated 3 in. and under; 1% for systems rated over 3 in.) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8 in. misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type that will hold ducts true to shape and to prevent buckling. Support vertical ducts at every floor. Seal all longitudinal and transverse duct joints and seams with non-hardening duct mastic.
- B. All round duct taps shall be conical type. All rectangular duct taps shall have 45° mitered entry per SMACNA.
- C. Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work.
- D. Field Fabrication: Complete fabrication of work at project as necessary to match shop fabricated work and accommodates installation requirements.
- E. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Where possible, locate insulated ductwork for 1 in. clearance outside of insulation. Limit clearance to 1/2 in. where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with structural members, suspended ceiling, lighting layouts, sprinkler piping, plumbing systems and similar finished work.
- F. Electrical Equipment Spaces: Do not route ductwork through Electric Rooms, transformer vaults, and other electrical equipment spaces and enclosures.
- G. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 in. Fasten to duct and substrate.
 - 1. Where ducts pass through fire rated floors, walls, or partitions, provide fire stopping between duct and substrate, in accordance with requirements of Division 07 Section "FIRE STOPPING".
- H. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- I. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

3.03 INSTALLATION OF FLEXIBLE DUCTS

- A. Maximum Length: For any duct run using flexible ductwork, do not exceed 6 ft. 0 in. extended length. Flexible ductwork shall be properly supported. Hangers and supports shall be double nipped top and bottom. Flexible ductwork shall only be used for connecting the branch duct to the diffuser.
- B. Installation: Install in accordance with Section III of SMACNA's, HVAC Duct Construction Standards, Metal and Flexible".

3.04 FIELD QUALITY CONTROL

- A. Leakage Tests: After installation of each duct system that is constructed for duct classes over 3 in. is completed, test for duct leakage. Repair leaks and repeat tests until total leakage is less than 1% of system design airflow.
- B. The testing shall be performed as follows:
 - 1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
 - 2. Use a certified orifice tube for measuring the leakage.
 - 3. Define section of system to be tested and blank off.
 - 4. Determine the percentage of the system being tested.
 - 5. Using that percentage, determine the allowable leakage (CFM) for that section being tested.
 - 6. Pressurize to operating pressure and repair any significant or audible leaks.
 - 7. Re-pressurize and measure leakage.
 - 8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.

3.05 EQUIPMENT CONNECTIONS

- A. General: Connect metal ductwork to equipment as indicated; provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.

3.06 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances that might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

- C. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until time connections are to be completed. Construction filtration must be properly maintained throughout the project.
- D. Balancing: Refer to Division 23 Section "TESTING, ADJUSTING AND BALANCING" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION

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**SECTION 23 3319
SOUND ATTENUATORS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of sound attenuators work required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Refer to other Division 23 sections for ductwork, and external insulation of sound attenuators; not work of this section.
- C. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of sound attenuators with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- D. Codes and Standards:
 - 1. NFPA Compliance: Construct sound attenuators using acoustical fill complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," latest edition.
 - 2. ASTM Compliances: Comply with applicable requirements of ASTM E90 and E477.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of sound attenuator furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop Drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data and parts list for each type of sound attenuator; including "trouble-shooting" maintenance guide. Include this data, product data, and shop Drawings in maintenance manual; in accordance with requirements of Division 01.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sound attenuators with identification on outside of casings indicating type of sound attenuator and location to be installed. Avoid crushing or bending, and prevent dirt and debris from entering and settling in sound attenuators.
- B. Store sound attenuators so as to protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 CROSS TALK SILENCERS

- A. General: Provide factory-fabricated and tested cross talk silencers as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Construction: Construct outer casing of 22-gauge and interior baffles of 26-gauge-galvanized steel. Lock form seams in outer casing. Provide glass fiber acoustical filler material, packed under compression. Construct so entire silencer is incombustible, moisture resistant, and imparts no odors to the ambient air.
- C. Pressure Drop: Provide units that have equal or less pressure drop than that scheduled, and certify that static pressure has been measured by independent laboratory in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating Purposes".
- D. Acoustical Characteristics: Provide units that have equal or greater noise reduction characteristics than those scheduled, and certify that noise reduction data has been measured by independent laboratory in accordance with ASTM E90, "Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions."
- E. Manufacturers: Subject to compliance with requirements, provide cross talk silencers of one of the following:
 - 1. Aeroacoustic Corporation.
 - 2. Gale Noise Control; Div of Norwood Manufacturing Corp.
 - 3. Industrial Acoustics Co.
 - 4. Rink Corp.
 - 5. Tempmaster Corp; Subs of Temperature Industries Inc.
 - 6. Titus Products; Div of Philips Industries Inc.
 - 7. Vibro - Acoustics
 - 8. Kinetics
 - 9. Price

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which sound attenuators are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF SOUND ATTENUATORS

- A. General: Install sound attenuators as indicated, and in accordance with manufacturer's installation instructions.
- B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

- A. Upon completion of installation and prior to initial operation, test and demonstrate that sound attenuators, and duct connections to sound attenuators, are leak tight.
- B. Repair or replace sound attenuators and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.04 CLEANING

- A. Clean exposed factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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**SECTION 23 3613
AIR TERMINALS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of air terminals work required by this section is indicated on Drawings and schedules, and by requirements of this section.
- B. Types of air terminals specified in this section include the following:
 - 1. Central Air Terminals:
 - a. Shutoff Single Duct
 - b. Reheat
- C. Refer to other Division 23 sections for external insulation of air terminals; not work of this section.
- D. Refer to other Division 23 sections for testing, adjusting and balancing of air terminals; not work of this section.
- E. Refer to other Division 23 sections for temperature controls that are to be furnished by others but installed as work of this section.
- F. Refer to other Division 23 sections for temperature controls for air terminals; not work of this section.
- G. Refer to Division 26 sections for the following work; not work of this section.
 - 1. Power supply wiring from power source to power connection on air terminals. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- H. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
 - 1. Control wiring between field-installed controls and air terminals.
 - a. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of air terminals with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:

1. ADC Compliance: Provide air terminals that have been tested and rated in accordance with ADC standards, and bear ADC Seal.
2. ARI Compliance: Provide air terminals that have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.
3. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Installation of Air Conditioning and Ventilating Systems", latest edition.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop Drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit ladder-type-wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
- D. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop Drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 01.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver air terminals wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.
- B. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide air terminals of one of the following:
 1. Anemostat Products Div.; Dynamics Corp. of America.
 2. Air Buensod, Inc.
 3. Carnes Co.
 4. ETI

5. Titus Products Div.; Philips Industries, Inc.
6. Carrier Corp.; Sub. of United Technologies Corp.
7. Tempmaster Corp.
8. Trane (The) Co.
9. Krueger
10. Price

2.02 AIR TERMINALS

- A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Casings: Construct of die-cast aluminum or sheet metal of the following minimum thickness:

	STEEL	ALUMINUM
Upstream Pressure Side:	24 gauge	0.032 in.
Downstream Pressure Side:	26 gauge	0.025 in.

1. Provide hanger brackets for attachment of supports.
 2. Linings: Line inside surfaces of casings with lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Secure lining to prevent delamination, sagging, or settling.
 - a. Cover liner surfaces and edges with coating or perforated metal.
 3. Access: Provide removable panels in casings to permit access to air dampers and other parts requiring service, adjustment, or maintenance.
 - a. Provide airtight gasket and quarter-turn latches.
 4. Leakage: Construct casings such that when subjected to 0.5-in wg. pressure for low-pressure units, and 3.0-in wg. pressure for high pressure units, total leakage does not exceed 4% of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0-in wg. inlet pressure with damper closed, total leakage does not exceed 10% of specified airflow capacity.
 5. Multiple Duct Connectors: For air terminals serving more than one air outlet, provide lined outlet plenum with duct collar, butterfly-type damper, and locking device in each outlet.
- B. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers that are calibrated in CFM, factory-adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper for minimum to maximum, in response from signal from thermostat.
 - C. Controls: Provide controls accurate to 1.5°F (0.8°C) and adjustable from 55°F (22°C) to 105°F (29°C).

1. Provide electronic DDC controls, compatible with electronic temperature control system specified in other Division 23 sections.
- D. Identification: Provide label on each unit indicating Unit Number, CFM range, CFM factory-setting, and calibration curve (if required).
- E. Central Air Terminals: Provide the following features and accessories indicated on Drawings and schedule:
 1. Hot Water Heating Coils: Provide heating coils constructed of copper tubes and aluminum fins with galvanized steel casing.

PART 3 - EXECUTION

2.01 INSPECTION

- A. Examine areas and conditions under which air terminals are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

2.02 INSTALLATION OF AIR TERMINALS

- A. General: Install air terminals as indicated, and in accordance with manufacturer's installation instructions.
- B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- C. Duct Connections: Connect ductwork to air terminals in accordance with Division 23 ductwork sections.

2.03 FIELD QUALITY CONTROL

- A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak tight.
- B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

2.04 CLEANING

- A. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

END OF SECTION

**SECTION 23 3713
AIR OUTLETS AND INLETS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of air outlets and inlets work is indicated by Drawings and schedules, and by requirements of this section.
- B. Types of air outlets and inlets required for project include the following:
 - 1. Ceiling return air grilles.
 - 2. Ceiling air diffusers.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
 - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets", latest edition.
 - 3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
 - 4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
 - 5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
 - 6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
 - 7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Installation of Air Conditioning and Ventilating Systems" latest edition.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 CEILING AIR DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of aluminum or steel, and as required for complete installation.
- B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction Drawings and specifications for types of ceiling systems that will contain each type of ceiling air diffuser. All air devices installed in plaster, gyp board or other hard ceilings or walls shall be provided with a separate mounting frame.
- D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on the air device schedule.
- E. Diffuser Finishes:
 1. Finish shall be off-white baked enamel.
 2. Color selection shall be from manufacturer's standard color chips, unless otherwise noted.
- F. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following:
 1. Metalaire,

2. Krueger,
3. Nailor,
4. Price,
5. Titus,
6. No Substitutions.

2.02 CEILING GRILLE

- A. General: Except as otherwise indicated, provide manufacturer's standard grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide grilles that have, as minimum, noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling construction with accurate fit and adequate support. Refer to general construction Drawings and specifications for types of ceiling construction that will contain each type of ceiling grille.
- D. Types: Provide ceiling grilles of type and with accessories as listed on the air device schedule.
- E. Grille Finishes:
 1. Finish shall be off-white baked enamel.
 2. Color selection shall be from manufacturer's standard color chips, unless otherwise noted.
- F. Manufacturer: Subject to compliance with requirements, provide grilles of one of the following:
 1. Metalaire,
 2. Krueger,
 3. Nailor,
 4. Price,
 5. Titus,
 6. No Substitutions.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to ensure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

END OF SECTION

SECTION 26 0000
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 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, 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.
 - 5. Commissioning of Electrical Systems: Refer to Section 019113 "Building Systems Commissioning" for Division 26 Electrical System commissioning requirements and Division 26 Contractor roles and responsibilities in the commissioning process.
- 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.

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 general requirements for the project electrical systems and equipment.
 - 1. Division 01 Sections included in the project specifications.
 - 2. The contract.

1.03 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.

1.04 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 at the time of bidding. Work, materials and equipment must comply with the latest rules and regulations of the following.
1. International Building Code
 2. Texas Accessibility Standards (State mandated)
 3. Americans with Disability Act (ADA)
 4. Association of Edison Illuminating Companies (AEIC)
 5. American National Standards Institute (ANSI)
 6. Institute of Electrical and Electronics Engineers (IEEE)
 7. Insulated Cable Engineers Association (ICEA)
 8. National Electrical Code (NEC)
 9. National Electrical Manufacturers Association (NEMA)
 10. National Electrical Safety Code
 11. National Fire Protection Association (NFPA)
 12. NFPA 70
 13. NFPA 101 Life Safety Code
 14. Underwriters' Laboratories (UL)
 15. FM Standards
 16. International Energy Conservation Code
 17. National Electrical Safety Code
 18. Occupational Safety and Health Act (OSHA)
 19. American Society for Testing and Materials (ASTM)
 20. University of North Texas Design and Construction Guidelines
 21. Applicable state and federal codes, ordinances and regulations
- B. 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 or shown.
- C. 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.

1.05 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 shall be 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 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. Equipment Layout Drawing: 1/4-inch scale minimum drawings indicating electrical equipment locations. Dimensions for housekeeping pads should be indicated on these drawings. Indicate routing of conduit 2 inches and over on these drawings.
- 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 will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to Owner.
- E. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record Drawings shall be transferred to AutoCad electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance.

1.06 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. The Contractor shall post and maintain warning and caution signage in areas where work is ongoing near energized equipment. The Contractor shall cover all energized live parts when work is not being done in the equipment. This includes lunch and breaks.
 - 3. 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.

1.07 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, switchgear, switchboard, 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. 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.

1.08 TEMPORARY POWER REQUIREMENTS

- A. Provide power distribution system sufficient to accommodate construction operations requiring power, use of 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 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. 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, 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.

1.09 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

2.01 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.

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. Install work in compliance with NEC latest edition.
- B. Install material and equipment in accordance with manufacturers' instructions. Provide calibrated torque wrenches and screwdrivers and tighten all terminals, lugs, and bus joints using it.
- 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 opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

3.02 SERVICE CONTINUITY

- A. Maintain continuity of electric service to entire facility. Phase construction work to accommodate Owner's occupancy requirements.
- B. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.

- C. All service outages shall be requested in writing a minimum of four 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, identification of areas impacted, and the time requirements.
- D. The Contractor shall obtain all appropriate Owner permits for working in equipment.

3.03 HAZARDOUS LOCATIONS

- A. Equipment, wiring, devices, and other components located within hazardous areas to be of 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.

3.04 SLEEVES AND SEALS

- A. Provide sealing and/or fire stopping where electrical system passes through walls, ceilings, and floors. Seals shall be watertight and/or fire rated as applicable.
- B. Where coring foundation walls, vault wall, etc., provide sufficient space between penetrations to maintain the structural integrity of the wall. Provide rubber sleeve equal to Link-Seal near the interior surface of the wall. The same space shall have waterproofing installed on the exterior side of the rubber seal.

3.05 CONSTRUCTION REVIEW

- A. The Engineer or Owner's representative will review and observe installation work to ensure 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.

3.06 WARRANTY

- A. Provide warranties in accordance with the requirements of Uniform General and Supplementary Conditions (UGC).

END OF SECTION

SECTION 26 0500
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 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.

1.02 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 basic electrical materials and methods shall follow the requirement set forth by this specification.

1.03 APPLICABLE CODES AND STANDARDS

- A. NFPA 70, National Electrical Code (latest edition)
- B. American National Standard C2, National Electrical Safety Code, (latest edition)
- C. Applicable publications of NEMA, ANSI, IEEE, and ICEA
- D. Underwriters Laboratories, Inc. Standards (UL)
- E. Federal, city, state, and local codes and regulations having jurisdiction
- F. OSHA requirements
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. NEMA WD 1 - General-Purpose Wiring Devices
- I. UL 98 - Enclosed Switches

1.04 INTENT

- 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.

1.05 SUBMITTALS

- A. Provide submittals in addition and in accordance with Section 260000, Basic Electrical Requirements, 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.

1.06 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

2.01 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 1. Exceptions shall be as specifically designated on the Drawings.

Table 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
Outdoor	Subject to windblown dust and rain, splashing water, and hose-directed water	NEMA 4
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.
 - 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.

2.02 CONTACTORS

- A. Acceptable Manufacturers
 - 1. General Electric Company
 - 2. Square D Company
- 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. Coil operating voltage; 110 volts, 60 Hz or as per drawings.
- E. Size: NEMA ICS 2; size as shown or as required.
- F. Contacts: Ampacity as indicated on Drawings; 600 Volts, 60 Hz. (minimum 30A).
- G. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.03 CONTROL RELAYS

- A. Acceptable Manufacturers
 - 1. Square D Company
 - 2. General Electric Type CR120A
- 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 with field convertible from ON delay to OFF delay and vice versa.
- D. Where latching (mechanically held) relays or motor thermal detector relays are specified or required, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.04 PUSH BUTTONS, AND SELECTOR SWITCHES

- A. Acceptable Manufacturers
 - 1. Square D
 - 2. General Electric
 - 3. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 260000 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 non-hazardous, 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.
- E. 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 260553.
- F. 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.

2.05 TERMINAL BLOCKS AND ACCESSORIES

- A. Signal And Control Terminals
 - 1. Acceptable Manufacturers
 - a. Phoenix Contact
 - b. Buchanan
 - c. Weidmüller
 - d. Entelec

- e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 230000 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 considered upon A/E approval following substitution procedure in 260000 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.

2.06 PENETRATION SEALING SYSTEMS (FIRE STOPS)

- A. Provide penetration sealing where conduit, etc. pass through rated walls, ceilings, and floors.

2.07 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.

PART 3 - EXECUTION

3.01 FABRICATION - CONTROL ENCLOSURES AND CABINETS

- A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.02 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.

3.03 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. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.
- B. 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).
- C. 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, they shall be provided to support conduits and flexible connections to control panels.

3.04 COORDINATION

- A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified by Engineer's field representative prior to installation.

END OF SECTION

**SECTION 26 0518
ELECTRICAL CONNECTIONS TO EQUIPMENT**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. The extent of electrical connections to equipment is indicated on the drawings and in schedules, in other Divisions of the specifications, and by the requirements of this section, and is hereby defined to include (but not necessarily limited to) connections for providing electrical power to equipment.
- B. The types of electrical connections specified in this section include, but are not necessarily limited to, the following:
 - 1. To lab equipment
 - 2. To motors
 - 3. To electric heaters
 - 4. To motor starters
 - 5. From motor starters to motors
 - 6. To HVAC control and other control devices
 - 7. To elevators and associated equipment
 - 8. Miscellaneous equipment

1.03 SUBMITTALS

- A. Submit manufacturer's product data on materials to be used on project.

PART 2 - PRODUCTS

2.01 MATERIALS AND COMPONENTS

- A. For each electrical connection indicated, provide a complete assembly of materials, including but not necessarily limited to the following:
 - 1. Pressure connectors
 - 2. Terminals (lugs)
 - 3. Electrical insulating tape
 - 4. Heat shrinkable tubing
 - 5. Cable ties
 - 6. Solderless wire nuts
 - 7. Conductors
- B. Furnish materials and components in compliance with equipment manufacturer's recommendations for the intended application.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated, in accordance with recognized industry practices to ensure that products serve the intended functions.
- B. Connect electrical power supply conductors to equipment conductors in accordance with other sections of the specifications and in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, match conductors of the electrical connection for proper interface between the electrical supply and the installed equipment.
 - 1. Cover splices with electrical insulation equivalent to, or of a higher rating, than insulation on the conductors being spliced.

2. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure a uniform and neat appearance where cables and wires are terminated.
 3. Trim cables and wires to be as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- C. Provide conduit for connections in accordance with other sections of the specifications.
- D. Coordinate installation of electrical connections to the equipment with equipment installation work and as follows:
1. Make electrical connections to equipment furnished under other sections of the Contract Documents.
 2. Furnish wiring, conduit, outlet boxes, disconnect switches, etc., as required for same throughout the project.
 3. Check the General Construction, Fire Protection, Plumbing, Heating and Air Conditioning plans and specifications and determine the amount of required wiring for final connections.
 4. Verify locations, horsepower, voltages, etc., of all such equipment as the work progresses.
 5. Advise the Architect/Engineer immediately, for clarification, if an apparent conflict arises in control wiring, power wiring, etc.
- E. Due to manufacturer's changes or substitutions, equipment furnished under the mechanical and other sections of the specifications may require different rough-in and power requirements than indicated on the plans. Secure detailed drawings from the Contractor furnishing the equipment, to determine actual rough-in locations, and conduit and conductor requirements to assure a proper and workmanlike installation.
- F. Install motor controls, safety switches, etc. for all equipment on unistrut with two coats of paint to match surrounding area.

3.02 FINAL CONNECTIONS FROM MOTOR STARTERS TO MOTORS

- A. Furnish and install conduit, wiring, disconnects, etc., as required to install final connections from motor starters to motors. Verify number and size of conductors and disconnecting means requirements. Partwinding, and wye-delta starting, as well as multi-speed motors may require multiple or six pole disconnects which shall be furnished and installed under this section of the Contract Documents.

3.03 FINAL CONNECTIONS FOR EQUIPMENT FURNISHED BY OWNER OR UNDER OTHER SECTIONS OF THE CONTRACT DOCUMENTS

- A. HVAC AND MECHANICAL EQUIPMENT: It is the Contractor's responsibility to obtain the submittal data for HVAC and mechanical equipment, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.
- B. ELEVATOR ELECTRICAL REQUIREMENTS:
1. Provide all labor and materials for all required Circuits and Grounding as required by Code. Upgrade or replace existing as necessary to comply with items listed below.
 2. Provide a main power disconnect for each elevator.
 3. Provide remote tripping and Fire Safety Interface.
 4. Meet, as a minimum, the requirements of NEC 620-51, and 620-62.
 5. Do not use or provide the same power source to power to a heat detector(s) used for shunt tripping. The heat detectors must activate the shunt trip through a separate power source. This dedicated power source is required to be monitored by the supervisory fire alarm system.
 6. Provide a fused, lockable, elevator cab light disconnect in the elevator equipment room for each elevator.
 7. Meet the requirements of NEC 620-22 (a) Car Lighting Source.
 8. Each cab light disconnect shall meet the requirements of NEC 620-51 (a), and 620-53.

9. Connections between the fire alarm devices and the elevator equipment shall not exceed 36 inches. Armored flex is not acceptable for these connections. Wiring for these connections shall be enclosed within minimum 3/4" EMT.
- C. FOOD SERVICE EQUIPMENT: Verify exact locations and dimensions of food service equipment with equipment plan furnished by Food Service Contractors or suppliers and make all necessary electrical connections. It is the Contractor's responsibility to obtain the submittal data for food service equipment, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.
- D. COLD AREAS:
1. Included within cold area conditions are the following:
 2. Packaged refrigerating equipment
 3. Install conduits with seals equal to Appleton EYS Series where entering or leaving cold area to prevent condensation on conduit.
- E. CASEWORK: Furnish and install receptacles, boxes, conduit, wiring and flexible metallic conduit associated with electrical power. Provide rough-in for telephone/data, audio/visual, etc.
- F. MODULAR FURNITURE: Provide base feeds served from floor where furniture is equipped with integral wiring system with wiring devices. Where outlets are not integral to modular furniture, coordinate exact locations prior to rough-in. Power poles are not to be used.
- G. TRASH COMPACTOR: It is the Contractor's responsibility to obtain the submittal data for trash compactor equipment, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.
- H. DOOR OPERATORS: It is the Contractor's responsibility to obtain the submittal data for door operator equipment, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.
- I. SEWAGE EJECTOR UNIT: It is the Contractor's responsibility to obtain the submittal data for sewage ejector equipment, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.
- J. SUMP PUMPS: It is the Contractor's responsibility to obtain the submittal data for sump pump equipment, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.
- K. LAB EQUIPMENT: It is the Contractor's responsibility to review laboratory equipment drawings and cut sheets and to obtain the submittal data, check the data, and provide required electrical, including conduit and conductors, circuit breakers, etc., to accommodate changes or variations in the drawings and/or specifications.
- L. OTHER EQUIPMENT AND SYSTEMS: It is the Contractor's responsibility to obtain the submittal data for other equipment and systems, check the data, and provide required electrical, including conduit and conductors, circuit breakers, fuses, disconnects, etc., to accommodate changes or variations in the drawings and/or specifications.

END OF SECTION

SECTION 26 0519
CABLE, WIRE AND CONNECTORS, 600 VOLT

PART 1 - GENERAL

1.01 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.

1.02 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 to 600 volt cable, wire and connectors shall follow the requirement set forth by this specification.

1.03 REFERENCES

- A. NEMA WC 3 - Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- B. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- C. ANSI/UL 83 - Thermoplastic-Insulated Wire and Cables
- D. NFPA 70 - National Electrical Code, latest edition
- E. NEFA - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- F. 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.

1.04 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01 for submittal requirement.
- B. Submit manufacturer's literature and specification data sheets for each item of cable, wire and connectors.
- C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years experience.

1.05 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. If more than three phase conductors are installed in a single raceway, the conductors shall be derated in accordance with the National Electrical Code. Increase wire size so that resulting ampacity, after derating factor is applied, is equal to or greater than ampacity of conductor specified.
- D. 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.
- E. 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 260553, Electrical Identification.
- F. Use compression lugs for all wiring termination's except on breakers or terminal strips in panel boards.

2.02 BUILDING WIRE

- A. Thermoplastic-insulated Building Wire: NEMA WC 5.
- B. Rubber-insulated Building Wire: NEMA WC 3.
- C. Feeders and Branch Circuits Larger than 10 AWG: 98% conductivity copper, soft-drawn, stranded conductor, 600 volt insulation, THHN/THWN. Use XHHW conductors where installed in conduit underground.
- D. Feeders and Branch Circuits 10 AWG and Smaller: 98% conductivity copper, soft-drawn, solid conductor, 600-volt insulation, THHN/THWN. Use XHHW conductors where installed in conduit underground.

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 degrees C dry, 75 degrees 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 degrees 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. 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:
 - a. Insulated.
 - 3. Material:
 - a. Copper (for CU to CU connection).
 - 4. Style: Pigtail connector.
Parallel and tee connectors equal to ILSCO and GTA and GTT with ILSCO insulating cover. Parallel and tee connections shall be used only where specifically detailed. (Split bolt type connectors are not permitted.)

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. Conductors shall be selected on the basis of their purpose and UL listing. Generally, use Types THWN and THHN in building interiors and other dry locations. Outdoors and underground in raceways, use Type XHHW.
- D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' in length, no conductor smaller than a No. 10 wire shall be used. Conductor sizes shown on drawings are minimum and shall be increased as necessary to comply with voltage drop restrictions specified herein. 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.
 - 1. 120/208 Volt Branch Circuits: The voltage drop in the case of 120/208 volt circuits shall not exceed 2.0% at maximum load and 70.0% power factor.
- E. Separate neutral conductors shall be provided for each phase of the same size for 120V single-phase circuits. Do not share neutrals between circuits.

- F. Remote control wires shall be no smaller than No. 14 conductors. Control wires shall be run in separate conduits. 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.
- G. Exposed wire and cable is not permitted. All wire and cable shall be installed in conduit.
- 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.
- I. Wiring within an Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wireways 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 bend 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 and sidewall pressure.
- 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.
- 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 equipment grounding conductor. Provide isolated ground conductor to all isolated ground receptacles. Provide isolated ground conductor in 120/208 volt feeders as noted on drawings. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.
- I. Provide separate conduit system for emergency power circuits. These circuits shall not share raceways with normal power or lighting circuits.
- J. Conductors carrying more than 150 volts to ground shall not be installed in conduits with conductors carrying less than 150 volts to ground.

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 shall be in conduit. 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. PVC jacketed cable shall not be installed or worked in any way at temperatures below 32 degrees F, unless cable has been previously stored in a heated area 48 hours prior to being pulled and transported to a heated pulling area.
- F. 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.
- G. Do not route power and control cables through communications rooms.
- H. Fire alarm cable shall be installed in a separate conduit system.
- I. Instrument Cable: Instrument cable shall be installed in 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.

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. Do not splice below grade or in outdoor pull boxes.
- 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. Do not energize.
- 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.
- G. 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.
- H. Identify conductors per Section 260553 - 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.
- D. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.
- E. Conductors may be run in parallel as shown on drawings, provided all paralleled conductors are the same size, length, and type of insulation. They shall be so arranged and terminated as to insure equal division of the total current between all conductors involved.

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 three (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

**SECTION 26 0526
GROUNDING**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Power system grounding.
- B. Communication system grounding.
- C. Electrical equipment and raceway grounding and bonding.

1.03 REFERENCES

- A. NFPA 70 - National Electrical Code, latest edition
- 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

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 and bonded system in accordance with Article 250 of the NEC.
- B. Ground generator system neutral to grounding electrode system.
- C. Provide communications system grounding conductor to MDF and each IDF as indicated on drawings.
- D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, boxes, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building, ground rods, encased electrodes, grounding conductor in raceways and cables, receptacle ground connectors, lightning protection counterpoise, 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 rods and encased electrodes on exterior of Building.
- G. A special chemical ground system to serve both lab and sensitive test equipment shall be provided.

1.05 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Grounding system components shall be as required to comply with the design and construction of the system indicated. Components shall be as indicated in manufacturer's submittal data.
- B. Ground conductors shall be stranded tinned, annealed copper cable of the sizes indicated on drawings. Bond grounding conductors at both ends of metallic conduit.
- C. Grounding clips shall be Steel City Type G, or equal.
- D. Ground Rods shall be copper-encased steel, 3/4" diameter, minimum length 10 feet.

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 external ground wire on 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. 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.
- K. Provide grounding and bonding at metering equipment and pad-mounted transformer in accordance.
- L. 120 volt single phase circuits shall have a dedicated separate neutral. Do not share neutrals. Replace existing circuits that share a neutral so that all existing and new circuits do not share a neutral. Provide additional conduits as required.
- M. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 3/0 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- N. Separately derived system such as UPS, etc. shall be grounded and bonded per NEC.

3.02 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

- B. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms. Provide additional ground rod as required until resistance reading is 2 ohms or less.

END OF SECTION

**SECTION 26 0529
SECURING AND SUPPORTING METHODS**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Raceway and equipment supports.
- B. Fastening hardware.
- C. Coordinate location of concrete equipment pads.

1.03 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

1.04 COORDINATION

- A. Coordinate with other trades where conduit 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.

1.05 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Support Channel: All non-corrosive locations: Hot-dip galvanized steel.
- B. Hardware: All non-corrosive locations: Hot-dip galvanized steel.
- C. Threaded Rod: Used for rack support from structure above; 1/4-inch minimum diameter.

2.02 CONDUIT ANCHORING

- A. Conduit shall be securely anchored with split ring hangers, conduit straps, or other devices specifically designed for the purpose. Wire ties and spring clips are specifically not permitted. Do not support conduits from ceiling support wires.

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 supports.
- 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. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- O. Install freestanding electrical equipment minimum on 4-inch concrete pads unless noted otherwise. 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:
 - P. Floor mounted switchgear
 - Q. Automatic transfer switches if floor mount type
 - R. Generator and pad mounted transformers shall be as detailed and noted on drawings.
- S. Do not anchor supports to columns. Where panelboards, cables, or conduits are routed on the face of a column provide "column hugging" channel supports.

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 0533
RACEWAYS, CONDUITS AND BOXES**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Raceways:
 - 1. Wireways.
- 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).
- 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.

1.03 REFERENCES

- A. NFPA 70 - National Electrical Code, latest edition
- 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/UL 1 - Flexible Metal Conduit
- I. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit
- J. ANSI/UL 467 - Electrical Grounding and Bonding Equipment
- K. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit (underground use only)
- L. ANSI/UL 797 - Electrical Metal Tubing
- M. ANSI/UL 870 - Wireways, Auxiliary Gutters and Fittings
- N. UL 6 - Rigid Metal Conduit
- O. ANSI/UL 5C - Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits
- P. ANSI/UL 498 - Attachment Plugs and Receptacles
- Q. ANSI/UL 943 - Ground Fault Circuit Interrupters

1.04 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01 for submittal requirements.
- B. Shop drawings 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. Sealing/fire stopping materials and details.
- D. Submit detailed shop drawing for Owner and Engineer approval showing all conduits 2" and larger. All conduits, regardless of size shall be concealed in finished areas of the building.

- E. Submit cable pulling tension and sidewall pressure calculations for all service and feeder conduits.

1.05 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

2.01 WIREWAYS

- A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.
- B. Submit proposed site and location for approval. Use wireways only where acceptable to Owner and Engineer.
- 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.

2.02 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. Control systems (other than HVAC)
 - 5. Division 28 systems
 - 6. 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.
- E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression water tight type. Expansion fittings shall be OZ Type TX.
- F. Flexible metal conduit and fittings shall be zinc-coated steel.
- G. Malleable metal fittings are not acceptable.
- H. 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.
- I. 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. 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.
- J. ENT is not acceptable.

- K. Provide strain relief fittings as manufactured by OZ for cables in vertical raceways.
- L. Crimp or set-screw type fittings are not acceptable.
- M. Minimum conduit size shall be 3/4-inch for branch circuits.
- N. Minimum conduit size shall be 1-inch for feeders.
- O. 1/2-inch flexible metal conduit may only be used for light fixture whips for lay-in fixtures. Minimum length 3'-0", maximum length 6'-0".
- P. MC Cable may be utilized for 120V, 20A branch circuits and lighting circuits where installed above accessible ceilings and within interior walls. It's use is acceptable only between last junction box and the wiring device or fixture. Home runs back to panel (source) shall be installed in conduit.

2.03 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 1-1/2 inch deep unless shallower boxes are required by structural conditions and are approved by the A/E.
- B. Outlets exposed to rain shall be equipped with cast metal in-use cover.
- C. Provide 4-inch octagonal ceiling outlet boxes.
- D. Surface mounted outlet boxes in interior locations shall be threaded cast type.

2.04 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 24 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.
- C. Boxes shall be sized in accordance with NEC.

PART 3 - EXECUTION

3.01 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. Raceway and conduit system shall be installed parallel and perpendicular to building lines unless indicated otherwise on the drawings.

- D. 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, exposed interior locations, exposed outdoor locations, damp locations or any location as per design drawing. The following exceptions permitted:
1. EMT
 - a. In sizes up to and including 4 inch, may be used inside dry locations where concealed above accessible ceilings or in dry wall partitions. EMT may not be used outside, in vault, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, or where exposed. EMT may be exposed in mechanical and electrical rooms where above 5'-0" AFF, but cannot be used for service entrance.
 2. PVC (underground use only)
 - a. Install PVC schedule 40 conduit where direct buried in earth.
 - b. Install PVC schedule 40 conduit where concrete encased in ductbank.
 - c. Underground 90s shall be long radius fiberglass.
 - d. Stub-ups shall be schedule 40 PVC.
 3. Liquid-tight
 - a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including mechanical equipment. Install external ground wire on flexible conduit with grounding bushings. Maximum length shall be 6 feet minimum of 2 feet.
 4. Flexible Metal Conduit
 - a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips with internal ground wire. Maximum length shall be 6 feet minimum of 3 feet; and minimum size shall be 1/2-inch for lay-in light fixture whips.
- E. 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 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. Do not install on roof without written permission from Owner. Conduits to rooftop equipment shall be installed in ceiling space and penetrate roof within equipment curb.
- F. Install conduits outside of building lines at a minimum depth of 30 inches below finished grade. Refer to ductbank details for additional depth requirements. Provide additional depth as required to maintain required separation from other utilities and to avoid obstructions. Maintain twelve inches earth or two inches concrete separation between electrical conduits and other services or utilities underground.
- G. Allow minimum 6" clearance from heat sources.
- H. Conduits running to rooftop and exterior wall mounted equipment shall be routed inside building and stubbed out at equipment.
- I. Install underground conduits with sealing glands equal to OZ Type FSK exterior to the conduit and OZ type CSB, or equal internally at the point where conduits enter the building to prevent water seepage into the building.

- J. Fittings shall be approved for grounding purposes or shall be jumpered with copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.
- K. 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
 - 2. Conduits entering environmental rooms and other locations subject to thermal expansion and 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 the green grounding conductors shall be accessible for inspection.
- L. Install conduit concealed in walls, partitions and above ceilings. Install conduit exposed in ceiling area (at structure) of electrical rooms and mechanical rooms.
- M. Horizontal runs of conduit within walls is not permitted.
- N. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
- O. 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.
- P. Provide 200 lb. nylon cord full length in empty conduit.
- Q. 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.
- R. 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.
- S. Pull string shall be provided full length in conduit designated for future use.
- T. Rigid steel conduit shall be taped where in contact with concrete. At the points where conduit penetrates concrete that is in contact with soil, the conduit shall be Schedule 80 PVC bedded in sand.

3.02 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.

3.03 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. Allow minimum 6" clearance from heat sources.
- E. Locate and install boxes to allow access, minimum 12 inches above ceiling except where space dimensions do not allow.

- F. 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.
- G. 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. Box may be supported to one stud only if installed using Erico Caddy H23/H4/HS3 Series box support with leg to prevent box from moving in stud wall.
- H. Provide knockout plugs for unused openings.
- I. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- J. Install boxes in walls without damaging wall insulation.
- K. 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.
- L. Outlet boxes for switch shall not be used as junction boxes.
- M. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
- N. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- O. 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.

3.04 WALL AND FLOOR PENETRATIONS

- A. Core drilling shall be approved by Owner prior to execution. X-ray for each required floor penetration. Avoid anchor bolt on structural column by installing "column hugging" type of unistrut support for electrical installation. PVC shall not be used for wall and floor penetration.
- B. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. Coordinate roof penetrations with the roofing contractor.

END OF SECTION

**SECTION 26 0553
ELECTRICAL IDENTIFICATION**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Nameplates and tape labels
- B. Wire and cable markers
- C. Conduit color coding and labeling

1.03 REFERENCES

- A. NFPA 70 - National Electrical Code (latest edition)

1.04 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01 for submittal requirement.
 - 1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

PART 2 - PRODUCTS

2.01 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 fire alarm system provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
- B. Underground Warning Tape
 - 1. Manufactured polyethylene material and unaffected by acids and alkalines.
 - 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 Tape and Heat Shrink:
 - 1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
 - 2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of wire or cables are not acceptable.
- D. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2" lettering.
- E. Receptacle, lighting control, and switch cover plates shall be custom engraved with panel and circuit breaker number. Stick-on tape label is not acceptable.
- F. J-Box cover plate labels (existing and new J-boxes): Black stenciled letters 1/4" high. Adhesive back tapes may be used if a clear tape is applied over the label for protection. Each J-box cover shall be labeled with voltage and each circuit number contained in J-box.
 - 1. White letters on black background for normal power.
 - 2. White letters on red background for emergency/standby power.

PART 3 - EXECUTION

3.01 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.

3.02 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. Verify existing color code and notify Engineer if different than below.

SYSTEM VOLTAGE	
Conductor	208/120V
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Grounding IG	Green Green w/Yellow

3.03 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 Switchboards, Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4-inch; identify source to device and the load it serves, including location.
- C. 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.
- D. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, voltage and bus rating.

3.04 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
FCMS	Green
Emergency Power	Red
Security**	White
Fire Alarm	Yellow

**Security shall include, but not be limited to, the following systems:

- Card Access
- Duress Alarms
- Perimeter Door Alarms
- CCTV

3.05 SWITCHGEAR LABEL

- A. Switchgear shall be labeled to include arc-flash labels, personal protective equipment (PPE) and other information as required by NEC 110.16 and as described in the standards and guidelines referenced in FPN Nos. 1 and 2.

END OF SECTION

**SECTION 26 0573
SYSTEM COORDINATION AND ANALYSIS**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Provide a complete analysis of the operation of the electrical power system under overcurrent and short circuit conditions (L-G, L-L and 3Ø bolted fault).
- B. Generator/ATS timing and delay functions.
- C. Provide complete arc-flash study and equipment labeling.

1.03 SUBMITTALS

- A. Analysis shall be performed by one of the following:
 - 1. Square D Systems Coordination Group
 - 2. Coordinated Power Systems - Hales Corner, Wisconsin
 - 3. ABB/General Electric
- B. Submit a preliminary analysis of the system for approval prior to a release for fabrication of electrical equipment.
- C. Submit final analysis of the system prior to the installation or energization of equipment.

1.04 REFERENCED STANDARDS

- A. The analysis of overcurrent operation shall be based on IEEE "Overcurrent Protective Device Coordination by Computer".
- B. The analysis of short circuit current operation shall be based on IEEE "Procedure for Determining Maximum Short Circuit Value in Electrical Distribution Systems".

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 SCOPE OF ANALYSIS

- A. The analysis shall be comprehensive from Northwest Substation, through new Vista switchgear, to oil-filled pad mounted transformers through the distribution system to the last overcurrent device serving equipment or outlets.
- B. The contribution of all motors one horsepower and larger shall be included.
- C. Include generator, automatic transfer switches and controls.
- D. Where operation from one or more sources is possible, all operating configurations shall be analyzed.

3.02 BASIS OF COMPUTATION

- A. Computation shall be based on infinite bus method. For arc-flash ratings, use actual available fault current values to determine recommended rating.
- B. Device characteristics and equipment impedances shall be obtained in writing from the equipment supplier.
- C. The preliminary analysis shall be based on the Contractor's estimation of feeder types and lengths and the proposed equipment characteristics.
- D. The final analysis shall be based on the equipment and materials actually installed at the project. Conductor and raceway type, lengths, and characteristics shall be supplied by the Contractor on the actual materials and routings to be installed.

- E. Coordination TCC's shall include all pertinent data including MAG-I, FLA, cable damage limit, fault current, partial one-line of devices plotted, motor stall, etc.
- F. All timing and delay functions associated with the generator system including automatic transfer switches shall be included in the analysis, such as delay to start, delay to transfer, etc.
- G. All timing and delay functions associated with main switchboard main-tie-main shall be included in the analysis.

3.03 RESULTS

- A. The overcurrent device coordination analysis shall present a graphic representation of the required time-current settings for every protective device in the system and a tabular listing for equipment calibration. All devices which are not able to be fully selectively coordinated shall be noted along with recommended action.
 - 1. All corrective action shall be included in bid.
 - 2. Provide mission critical breakers or breakers with additional trip features as required for code required coordination.
- B. The short circuit analysis shall list the phase and ground fault current available at each switchgear, switchboard and panelboard bus in the system, and define whether each device in the system is adequately rated for the duty imposed. Contractor shall furnish equipment with AIC rating which exceeds maximum available fault current regardless of rating specified on drawings. Equipment ratings on drawings are minimum AIC duty and shall not be reduced.
- C. Series rating is not permitted.
- D. Label switchgear based on results of arc-flash study.

3.04 DEVICE FEATURES, SIZES AND RATINGS

- A. In accordance with coordination study and arc-flash study, provide all "recommended" and "required" device features, sizes and ratings at no additional cost including but not limited to:
 - 1. NEC arc-energy reduction. Provide equipment and/or breaker features as necessary to limit arc-flash energy per NEC.
 - 2. Emergency branch coordination.
 - 3. Other protection or coordination issues.
 - 4. Provide mission critical breakers or breakers with additional trip features as required for code required coordination.

END OF SECTION

**SECTION 26 0936
MODULAR DIMMING CONTROLS**

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
1. Ceiling mounted occupancy/vacancy sensors including dual technology, microphonic, and passive infrared technologies. This includes self-contained PIR sensors as well as low voltage sensors that work with switchpacks.
 2. Wall mounted lighting control stations.

1.03 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) (www.ansi.org and www.ieee.org)
1. C62.41-1991 - Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- B. ASTM International (ASTM) (www.astm.org)
1. D4674 - 02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor LED, Fluorescent Lighting, and Window-Filtered Daylight.
- C. Canadian Standards Association (CSA) (www.csa.ca).
1. CSA C22.2 # 14 Industrial Control Equipment
 2. CSA C22.2 # 184 Solid-State Lighting Controls
 3. CSA C22.2 # 156 Solid-State Speed Controls
- D. International Electrotechnical Commission (www.iec.ch).
1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
 2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- E. International Organization for Standardization (ISO) (www.iso.ch):
1. 9001:2000 - Quality Management Systems.
- F. National Electrical Manufacturers Association (NEMA) (www.nema.org)
1. WD1 (R2005) - General Color Requirements for Wiring Devices.
- G. Underwriters Laboratories, Inc. (UL) (www.ul.com):
1. 94 - Flammability Rating
 2. 916 - Energy Management Equipment.
 3. 508 (2005) - Standard for Industrial Control Equipment.
 4. 244A - Appliance Controls

1.04 SYSTEM DESCRIPTION

- A. Permanently Installed
1. Ceiling mounted occupancy/vacancy sensors
 2. Switchpacks
 3. Wall mounted lighting control stations

1.05 SUBMITTALS

- A. Submit under provisions of Section 013300.
- B. Specification Conformance Document: Indicate whether the submitted equipment:
1. Meets specification exactly as stated.
 2. Meets specification via an alternate means and indicate the specific methodology used.

- C. Shop Drawings shall include:
 - 1. Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
 - 2. Schematic of system.
 - 3. Lighting plan clearly marking product type, location and orientation of each sensor.
- D. Product Data: Catalog specification sheets with performance specifications demonstrating compliance with specified requirements.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Minimum 15 years experience in manufacture of occupancy/vacancy sensor lighting controls.
- B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
- C. Occupancy/vacancy Sensing Lighting Controls:
 - 1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.
- D. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
- E. Source Limitations: To assure compatibility, obtain occupancy/vacancy sensors from a single source with complete responsibility over all lighting controls, including accessory products. The use of subcontracted component assemblers is not acceptable.

1.07 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient temperature: 0° to 40°C (32° to 104°F).
 - 2. Relative humidity: Maximum 90 percent, non-condensing.
 - 3. Occupancy/vacancy Sensors must be protected from dust during installation.

1.08 WARRANTY

- A. Provide manufacturer's 5 year parts warranty.

1.09 MAINTENANCE

- A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.
- B. Make new replacement parts available for minimum of ten years from date of manufacture.
- C. Provide factory direct technical support.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Acuity Brands Lighting, Inc. – nLight

2.02 SENSOR PERFORMANCE REQUIREMENTS

- A. Sensing Mechanism:
 - 1. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 - 2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies are not acceptable.
 - 3. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional "dual" technology shall be used.

4. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are not acceptable.
 5. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies are not acceptable.
- B. Power Failure Memory:
1. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
- C. Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
- D. Coverage Patterns are tested and verified using the NEMA WD 7 Standard.
- E. Sensor shall have time delays from 10 to 30 min.
- F. When required, sensors shall automatically adjust time delay and sensitivity settings.
- G. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- H. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- I. Where required, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed, and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

2.03 CEILING MOUNTED SENSORS (LOW VOLTAGE)

- A. Product CM 9, CM 10, CM PDT 9, CM PDT 10, as well as nLight Series
- B. Provide all necessary mounting hardware and instructions.
- C. Sensors shall be Class 2 devices.
- D. Provide an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.
- E. Where required, sensors shall offer integral Bi-level Automatic-On (just one lighting level comes on automatically when occupancy/vacancy is detected)
- F. Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- G. Shall have no leakage current to load for safety purposes and shall have voltage drop protection.
- H. Where required, shall offer zero time delay mode and be able to actuate the output for one second to signal another device that the space being monitored is occupied. Applications may include the use of a lighting control system to manage the delay of the lighting deactivation.
- I. Shall have a Tracking/HVAC mode that allows the load connected to the Form C BAS relay to remain on when the lights are turned off manually.
- J. Walk through feature shall shut off lights within 2 minutes after momentary occupancy/vacancy.
- K. Sensors shall be RoHS compliant.

2.04 SENSOR SWITCHPACKS

- A. Product: MP-20, PP-20, nPP16 and nPP16D
- B. Control wiring between sensors and control units shall be Class 2, 18-24 AWG, stranded U.L. Classified, PVC insulated in conduit.

- C. Integrated, self-contained unit consisting internally of an isolated load switching control relay and a power supply to provide low-voltage power.
- D. Shall be compatible with magnetic or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.

2.05 MODULAR SYSTEM WALL SWITCHES AND DIMMERS

- A. Devices shall recess into single-gang switch box and fit a standard GFI opening.
- B. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
- C. All devices shall have two RJ-45 ports.
- D. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
- E. Devices shall be white.
- F. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
- G. Devices with mechanical push-buttons shall have custom button labeling.
- H. Wall switches and dimmers shall be the following nLight model numbers, with device options as specified:
 - 1. nPODM (single on/off, push-buttons, LED user feedback)
 - 2. nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
 - 3. nPODM 2P (dual on/off, push-buttons, LED user feedback)
 - 4. nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
 - 5. nPODM 4P (quad on/off, push-buttons, LED user feedback)
 - 6. nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

2.06 SOURCE QUALITY CONTROL

- A. Perform full-function testing on 100% of all system components and panel assemblies at the factory.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with manufacturer's installation instructions.
- B. Provide complete installation of system in accordance with Contract Documents.
- C. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- D. Sensors shown on drawings are minimum quantity to be provided. Provide additional occupancy/vacancy sensors as required to provide full (100%) room coverage.

3.02 TESTING

- A. Upon completion of all wiring and after all fixtures are installed and lamped, a representative shall check the installation prior to energizing the system. Each installed occupancy/vacancy sensor shall be tested in the test mode to see that lights turn off and on based on occupancy/vacancy.
- B. At the time testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

END OF SECTION

**SECTION 26 0943
NETWORK LIGHTING CONTROLS**

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
1. Network integrated power switching systems.
 2. Network light dimming controls.
 3. Network lighting control with 0-10V dimming, switching, remote control of multiple user presets, and room occupancy and daylight sensing for daylight harvesting and energy management.
 4. Main control panel shall be programmed for time of day of each zone with pre-programmed override functions as determined by the Owner.
 5. Wall mounted lighting control stations.
- B. Related Information:
1. Modular lighting controls.

1.03 REFERENCES

- A. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code.
- B. Underwriters Laboratories (UL)
1. UL 508 - Industrial Control Equipment

1.04 ABBREVIATIONS

- A. BAS: Building Automation System.
- B. AV: Audio Visual.

1.05 SYSTEM DESCRIPTION

- A. Web Accessible, network connected, lighting control system utilizing preset control software, central signal microprocessor, including solid-state power switching modules and relays.
- B. System Components: System includes the following addressable components:
1. Keypad controls.
 2. Touch panel controls.
 3. Remote occupancy sensors.
 4. Timed room lighting.
 5. Daylight compensating lighting controls.
 6. Lighting management panels.
 7. Lighting management modules.
 8. Interface to building automation system - contact closure inputs standard, full integration modules must be available.
- C. System Communication:
1. RS232 interface for AV.
 2. Native communication with building wide Audio Visual Systems.
 3. Provide system interface with campus building automation system.

1.06 ACTION SUBMITTALS

- A. Product Data: For each type of product required for complete network lighting control system, demonstrating compliance with requirements.

- B. Shop Drawings: Indicated the following:
 - 1. Schematic diagram showing complete network lighting control system and accessories.
 - 2. Circuits and emergency circuits with capacity and phase, control zones, load type and voltage per circuit.

1.07 INFORMATIONAL SUBMITTALS

- A. Buy American Act certificate.
- B. CEC CCR Title 24 appliance efficiency listing certification.
- C. Sample of manufacturer's warranty.
- D. Load Measurement Report: Submit field test report of completed installation.

1.08 CLOSEOUT SUBMITTALS

- A. Operating and maintenance instructions.

1.09 QUALITY ASSURANCE

- A. Manufacturer Qualification: Manufacturer of network lighting controls with minimum five years record of satisfactory manufacturing and support of components comparable to basis of design system.
- B. Source Requirements: Provide Network Lighting Controls through a single source from a single manufacturer.
- C. Manufacturer Qualifications: Approved manufacturer of network lighting controls listed in this Section with minimum five years record of satisfactory manufacturing and support of components comparable to basis of design system.
 - 1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
 - a. Product data, including certified independent test data indicating compliance with requirements.
 - b. Samples of each component.
 - c. Sample submittal from similar project.
 - d. Project references: Minimum of 5 installations not less than 5 years old, with Owner and Architect contact information.
 - e. Sample warranty.
 - 2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
 - 3. Approved manufacturers must comply separate requirements of Submittals Article.
- D. Electrical Components, Devices, and Accessories: UL listed and labeled per NFPA 70.
- E. Buy American Act Certification: Submit documentation certifying that products comply with provisions of the Buy American Act 41 U.S.C 10a - 10d.

1.10 COORDINATION

- A. Coordinate integrated lighting and dimming controls with systems and components specified in the following sections:
 - 1. Division 11 Section "Audio-Visual Equipment".
 - 2. Division 27 Section "Communications Horizontal Cabling".

1.11 PROJECT CONDITIONS

- A. Environmental Conditions Range:
 - 1. Temperature: 32 - 104 deg. F (0 - 40 deg. C).
 - 2. Relative Humidity: 10 - 90 percent, noncondensing.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of modular dimming controls system the fail in materials or workmanship within the specified warranty period following substantial completion.
 - 1. Warranty Period: 100% parts replacement: Two (2) years.

2. Provide new parts, upgrades, and /or replacements available for a minimum of 5 years available to end user.
- B. Manufacturer's Extended Support Service: Extended telephone support: Unlimited period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Acuity Brands - Fresco.

2.02 SYSTEM CHARACTERISTICS

- A. Touch-screen based, network-connected programmable lighting control system that receives digital or analog signals from addressable input devices, assembles signals at central signal processor, and distributes operating signals to addressable control devices that effect a change in state.
 1. Provide system hardware that is designed, tested, manufactured, warranted by a single manufacturer
 2. Operational Life: At least 10 years expected life while operating within the specified ambient temperature and humidity range
 3. Standard Compliance & Compatibility: Provide architectural control product with native DMX512-A control
 4. Luminaire Compatibility: Supports RGB luminaires in 8 bit and/or 16 bit configurations also supporting MSB or LSB first luminaire settings.
 5. Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2
 6. Power Failure Memory: automatically store system settings and recover from a power failure without requiring user input
 7. Wireless devices:
 - a. Automatically sync for system operation without addressing
 - b. Send and receive messages for real-time operation and feedback
 - c. Use industry standard RF protocols
 - d. Be in compliance with FCC and IEE standards
 8. Time Clock: automatically adjust for daylight savings time and leap year

2.03 DIMMING AND SWITCHING PERFORMANCE REQUIREMENTS

- A. Electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor's maximum temperature rating when the device is under full load
- B. Inrush tolerance: Use MOSFET that has a maximum rating of six times the operating current of the dimmer/relay
- C. Surge tolerance: Panels are designed and tested to withstand surges of 6,000V, 3,000amps according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to performance
- D. Power failure recovery: When power is interrupted and subsequently restored, within 3 seconds lighting to automatically return to same levels prior to power failure
- E. Utilize half cycle to half cycle zero cross movement to allow for voltage compensation in order to overcome line noise and lamp flickering
- F. Incorporate electronic soft start default at initial turn-on that smoothly ramps lights to appropriate levels within 0.5 seconds
- G. Utilize air gap off to disconnect the load line from the line supply
- H. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable
- I. Assign load type to each dimmer that will provide proper dimming curve for the specific light source to be controlled
- J. Minimum and maximum light levels are user adjustable on a circuit by circuit basis

2.04 TOUCH PANEL CONTROLS

- A. Product: Fresco Touch Screen (7TSN)

- B. Preset lighting scene controller (located at reception area)
1. General Requirements:
 - a. 7" full color multi-touch capacitive touchscreen for controlling lighting and system components (quantity of touchscreens as required for all zones specified on drawings).
 - b. Control up to 36 dynamic lighting zones/scenes per touch screen
 - c. Link up to 8 touch screens for a possibility of 288 lighting zones/scenes
 - d. Connect up to 128 network devices per touch screen
 - e. On screen lighting design
 - f. Lighting zones/scenes can be comprised of lighting intensity, color, color temperature, and luminaire position
 - g. Modify color and color temperature using a digital color palette and UV rating scale
 - h. Proximity screen sensor for auto "wake-up"
 - i. Auto dimming and user adjustable backlight
 - j. User programmable screen lock limiting access to all feature control and programming
 - k. Full alpha-numeric scene and zone naming
 - l. Configurable interface to reflect project requirements
 - m. Lighting zones/scenes support control of forward/reverse phase dimming, 0-10v, RGB, nLight® enabled luminaires, nLight® power packs, DALI, tunable white and moving fixtures
 - n. Integral astronomical time clock enables lighting scenes
 - o. Partition status control and visualization
 - p. Direct DMX control for a single universe (512 slots)
 - q. Connect up to 128 nLight® enabled devices
 - r. Digital motion sensor control
 - s. Digital daylight harvesting response
 - t. RS-232/contact closure capable for 3rd party integration
 - u. Local wireless Bluetooth connectivity with mobile app
 - v. Compatible with Fresco Lighting Management Panels (LMP)
 - w. Frame Color: As selected by Architect
 2. Electrical:
 - a. Fresco Input: 24VDC
 - b. Fresco Power Supply: 120V AC
 - c. RS-485 network terminal
 - d. nLight enabled RJ-45 ports (in/out)
 - e. CAT5e Ethernet network terminal
 - f. DMX/RDM network terminal
 3. Mounting:
 - a. Installs in a standard triple gang US back box
 - b. Remote mounted power supply
 - c. Plug in wire harness for RS-485 and DMX connections
 4. Protocols:
 - a. RS-485
 - b. IEEE 802.15 Bluetooth compliant
 - c. Controller is compliant to industry standard ANSI E1.11 - 2008, USITT DMX512-A
 - d. Supports extended RDM capability as defined by ANSI E1.20
 - e. IEEE 802.11 Ethernet compliant
 - f. nLight Digital communication

2.05 NETWORKED SYSTEM WALL SWITCHES & DIMMERS

- A. Devices shall recess into single-gang switch box and fit a standard GFI opening.
- B. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.

- C. All devices shall have two RJ-45 ports.
- D. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
- E. Devices shall be white.
- F. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
- G. Devices with mechanical push-buttons shall be made available with custom button labeling
- H. Wall switches & dimmers shall be the following nLight model numbers, with device options as specified:
 - 1. nPODM (single on/off, push-buttons, LED user feedback)
 - 2. nPODM DX (single on/off, single dimming raise/lower, push-buttons, LED user feedback)
 - 3. nPODM 2P (dual on/off, push-buttons, LED user feedback)
 - 4. nPODM 2P DX (dual on/off, dual dimming raise/lower, push-buttons, LED user feedback)
 - 5. nPODM KEY (key switch): Use for entry stations, programmed as directed by Owner.
 - 6. nPODM 4P DX (quad on/off, quad dimming raise-lower, push-buttons, LED user feedback)

2.06 MOBILE CONTROLLER

- A. Fresco iPad Application
- B. Allows mobile control and programming of the Fresco Touchscreen (7TSN)
 - 1. General Requirements:
 - a. Mobile Apple device supports Bluetooth communication protocol
 - b. Provides user control and edit capability of lighting scenes and zones
 - c. Edit intensity, color, color temperature, and movement
 - d. Edit lighting schedules
 - e. Restrict number of users able to connect to touchscreen
 - f. Restrict access to making system changes
 - g. No PC required for mobile operation

2.07 NETWORKED SYSTEM POWER (RELAY) PACKS

- A. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.
- B. Power Packs shall accept 120 VAC, be plenum rated, and provide Class 2 power to the system.
- C. All devices shall have two RJ-45 ports.
- D. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
- E. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
- F. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
- G. Power Packs and Power Supplies shall be available that are WiFi enabled.
- H. Power Packs (Secondary) shall be available that provide up to 16 Amp switching of all lighting load types.

- I. Power Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or LED drivers.
- J. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
- K. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
- L. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
- M. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
- N. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
- O. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.
- P. Power (Relay) Packs and Supplies shall be the following nLight model numbers:
 - 1. nPP16 (Power Pack w/ 16A relay)
 - 2. nPP16 D (Power Pack w/ 16A relay and 0-10VDC dimming output)
 - 3. nPP16 WIFI (Power Pack w/ 16A relay, WIFI enabled)
 - 4. nEPP5 D (Power Pack w/ 5A relay and 0-10VDC dimming output)
 - 5. nSP16 (Secondary Pack w/ 16A relay)
 - 6. nPP16 ER (UL924 Listed Secondary Pack w/ 16A relay for switching emergency power circuits)
 - 7. nPP16 D ER UL924 Listed Secondary Pack w/ 16A relay and 0-10VDC dimming output for switching/dimming emergency power circuits)
 - 8. nSP5 PCD MLV (Secondary Pack w/ 5A relay and magnetic low voltage dimming output)
 - 9. nSP5 PCD ELV 120 (Secondary Pack w/ 4A relay and electronic low voltage dimming output)
 - 10. nSP5 2P LVR (Louver/Damper Control Pack)
 - 11. nSHADE (Pulse On/Off Control Pack)
 - 12. nPP20 PL (Secondary Pack w/ 20A relay for general purpose receptacle load)
 - 13. nPS 80 (Auxiliary Bus Power Supply)
 - 14. nPS 80 WIFI (Auxiliary Bus Power Supply, WiFi enabled)
 - 15. nAR 40 (Low voltage auxiliary relay pack)

2.08 DIGITAL SENSORS

- A. Wired Networked Occupancy/Vacancy Sensors/Photocells
- B. Products: Network Daylight Sensors (nLight)
 - 1. nCM ADCX (0-10v dimming, No Relay)
- C. Products: Network Standard Range 360° Ceiling Mount Sensors (nLight)
 - 1. nCMPDT9 (Low Voltage, Dual Tech)
 - 2. nCMRPDT9 (Line Voltage, Dual Tech)
 - 3. nCMR92P (Line Voltage, PIR, 2-Pole)
 - 4. nCMRPDT92p (Line Voltage, Dual Tech, 2-Pole)
 - 5. nCM92P (Low Voltage, PIR, 2 Channels)
 - 6. nCMR9 (Line Voltage, PIR)
 - 7. nCM9 (Low Voltage, PIR)
 - 8. nCMPDT92P (Low Voltage, Dual Tech, 2 Channels)
- D. Products: Specialty I/O Devices (nLight)
 - 1. nIO (Contact closure or 0-10VDC dimming)
 - 2. nIO LEDG LC (Fixture embedded Accudrive driver with Lumen Compensation)
 - 3. nIO EZ LC (Fixture embedded eldoLED driver dimming interface)
 - 4. nIO RLX (Raise/lower switch interface)
 - 5. nIO X (External digital system interface)
- E. General requirements

1. Occupancy sensors sense presence of human activity within the desired space and control on/off function of the lights
2. Utilize passive infrared (PIR) technology which detects occupant motion
3. Dual technology sensors utilize PIR/Microphonics (also known as Passive Dual Technology or PDT)
4. Sensors utilizing Microwave or Ultrasonic technology will not be accepted
5. Sensors are available with zero, one, or two Class 1 switching relays, and up to one 0-10VDC dimming output.
6. Provide multiple lens options which are interchangeable for specific applications
7. Communication and Class 2 low voltage power is delivered to each device with CAT-5 cabling and terminate with RJ-45 connectors
8. All sensors have two RJ-45 ports for purpose of daisy chain wiring method
9. Sensors are equipped with automatic override for 100 burn-in of lamps
10. Sensors capable of being embedded into luminaire
11. Photocells provide on/off set-point and deadband to prevent artificial light from cycling
12. Photocell and dimming sensor set-point is automatically calibrated using sensor microprocessor
13. Photocell min/max thresholds may be manually configured
14. Dimming sensors control 0-10VDC dimmable ballasts by sinking up to 20mA of Class 2 current

2.09 DEVICE QUALITY

- A. Perform 100% function testing of all device

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Follow manufacturer's instructions for all installation steps
- B. Provide a complete installation per Contract Documents
- C. Properly terminate all DMX wiring per installation instructions
- D. Use only recommended DMX cable and follow local codes
- E. Properly terminate all CAT5 wiring per installation instructions

3.02 MAINTENANCE

- A. Factory trained service technicians available within the continental US
- B. Integrated help on-screen and via online videos
- C. Factory telephone support via toll free line.

3.03 SOFTWARE

- A. Install and program software to meet the Owner's requirements. Provide current licenses. And backup copies of the software for the Owner's records.

3.04 SYSTEM STARTUP

- A. Provide manufacturer's system startup and adjustment.
- B. Switch each load on and off with manual line test feature of the power switching module before installing processors.
- C. Perform operational testing to verify compliance with Specifications. Adjust as required.

3.05 ADJUSTING

- A. Within 12 months of the date of Substantial Completion provide onsite service to adjust the system to account for actual occupied conditions.

3.06 DEMONSTRATION

- A. Factory authorized service representative to instruct owner's staff to adjust, operate and maintain network power switching systems; and provide instruction using the system software.

3.07 CLOSEOUT ACTIVITIES

- A. Demonstration: Schedule demonstration with Owner.
- B. Training: Train Owner's personnel to operate, maintain, and program network power switching systems. Allow for a minimum of trips to the jobsite to provide additional training as needed.
 - 1. Furnish set of approved submittals, and record drawings of actual installation for Owner's personnel in attendance at training session.

END OF SECTION

**SECTION 26 2416
PANELBOARDS**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Distribution panelboards.
- B. Branch circuit panelboards.

1.03 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- B. NAME KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- C. NEMA PB 1 - Panelboards.
- D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- E. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.
- F. NEMA AB 3 - Molded Case Breakers and Their Application
- G. ANSI/UL 67 - Electric Panelboards
- H. ANSI/UL 50 - Cabinets and Boxes
- I. ANSI/UL 508 - Industrial Control Equipment

1.04 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01 for submittal requirement.
- B. Submit dimensioned drawings showing size, circuit breaker arrangement and equipment ratings including, but not limited to, voltage, main bus ampacity, integrated short circuit ampere rating, and temperature rating of circuit breaker terminations.
- C. Submit 1/4" scale drawing of each electrical room and other rooms with electrical equipment to demonstrate that all equipment being submitted will fit in the space and all clearances are obtained. This drawing must be included with the submittal for equipment specified in this section.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver distribution panelboards in factory-fabricated water-resistant wrapping.
- B. Handle panelboards carefully to avoid damage to material component, 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. Eaton
- C. Siemens
- D. GE/ABB

2.02 PANELBOARD CONSTRUCTION

- A. General: Provide flush or surface mounted, circuit breaker type distribution or branch circuit panelboards with electrical ratings and configurations, as indicated on the drawings and schedules. Load center type panelboards are not acceptable.

- B. Enclosure:
1. Enclosure shall be proper NEMA type as indicated.
 2. NEMA 1 (Indoors)
 - 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 panelboard fronts with door-in-door cover.
 3. Construct cabinet in accordance with UL 50. Use not less than 16-gauge 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.
 4. Exterior and interior steel surfaces shall be cleaned and finished with gray enamel over rust inhibiting phosphatized coating. Color shall be ANSI 61 gray.
 5. Doors shall be equipped with flush-type combination catch and key lock. All locks shall be keyed alike.
 6. Branch circuit panelboards shall be 5-3/4-inches deep.
 7. A directory holder with heavy plastic plate, metal frame, and index card shall be mounted inside of each door.
 8. Reinforce enclosure and securely support bus bars and overcurrent devices to prevent vibration and breakage in handling.
 9. Rating: Minimum integrated short-circuit rating, voltage and current rating as shown on drawings.
 10. Labeling: The Contractor shall furnish and install engraved, laminated plastic nameplates on the trim per Section 260553, Electrical Identification
- C. Bus:
1. Provide panelboards with copper rounded edge phase, neutral and ground buses, rated full capacity as scheduled on drawings. Buses shall be full-length and braced for the maximum available fault current as shown on drawings.
 2. Phase bussing shall be stacked front-to-back, A-B-C.
 3. 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. 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.
 4. All lugs for phase, neutral, and ground buses shall be tin-plated copper.
 5. Neutral and ground buses shall be tin-plated copper.

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. Piggyback breakers are not permitted.
- D. Provide handle padlock attachments on circuit breakers where required. Device shall be capable of accepting a single padlock. All circuit breakers shall be capable of being individually padlocked in the off position.

- E. 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.
- F. All circuit breakers shall be provided with visible ON and OFF indications.
- G. Provide GFI circuit breakers as indicated on drawing and per NEC requirement.
- H. 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.
- I. 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.

2.04 DEVICE FEATURES, SIZES AND RATINGS

- A. In accordance with coordination study and arc-flash study, provide all "recommended" and "required" device features, sizes and ratings at no additional cost including but not limited to:
 - 1. NEC arc-energy reduction. Provide equipment and/or breaker features as necessary to limit arc-flash energy per NEC.
 - 2. Emergency branch coordination.
 - 3. Other protection or coordination issues.
 - 4. Provide mission critical breakers or breakers with additional trip features as required for code required coordination.

2.05 SURGE PROTECTION

- A. Surge protective devices (SPD) shall be installed at the first distribution panel/switchboard on the load side of each automatic transfer switch and dry type transformer. SPDs shall also be installed at each emergency system panel. Include 3-pole breaker in panelboard and conduit/conductors to surge protective device. Breaker and conduit/conductors shall be size as recommended by manufacturer. Breaker is not shown on Panel Schedule.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D
 - 2. Eaton
 - 3. Siemens
- C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 - 1. Fabrication using bolted compression lugs for internal wiring.
 - 2. Integral disconnect switch.
 - 3. Redundant suppression circuits.
 - 4. Redundant replaceable modules.
 - 5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 6. LED indicator lights for power and protection status.
 - 7. Audible alarm, with silencing switch, to indicate when protection has failed.

- 8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Integrate with building automation system.
- 9. Six-digit, transient-event counter set to totalize transient surges.
- D. Minimum Surge Current Capability (single pulse rated) per phase:
 - 1. Panelboards: 100 kA
- E. SPD shall be UL labeled as Type 1 (verifiable at UL.com), intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls.
- F. SPD shall provide surge current paths for all modes of protection: L-N, L-G, and N-G for Wye systems; L-L, L-G in single phase systems.
- G. UL 1449 Third Edition Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	700V	700V	1200V	700V

- H. UL 1449 Third Edition Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V

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. Anchor enclosed firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secured. Direct attachment to dry wall is not permitted. Freestanding panelboards shall be installed on a concrete housekeeping pad with anchors per manufacturer's recommendation.
- C. Mounting height:
 - 1. Distribution Panelboards: Such that highest operating handle is no greater than 79 inches above finished floor.
 - 2. Branch Circuit Panelboards: 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 used 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 260553, Electrical Identification.

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.

3.03 PANELBOARD SCHEDULE

- A. The Contractor shall provide engraved, laminated plastic nameplates for circuit identification as indicated on the Drawings for distribution panelboards.

- B. The Contractor shall fill the index directory inside the front door of branch circuit panelboards identifying each existing and new circuit. Where changes are made, the schedule shall reflect the changes. At the end of the job, these schedules shall reflect as-built record conditions.

END OF SECTION

**SECTION 26 2726
WIRING DEVICES**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Wiring Devices:
 - 1. Wall switches.
 - 2. Receptacles.
 - 3. Device plates and box covers.
- B. Wiring devices for HVAC in Division 23 shall meet the requirement of this specification.

1.03 REFERENCES

- A. Americans with Disabilities Act (ADA)
- B. ANSI/NEMA OS 1- Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- C. ANSI/UL 20 - General Use Snap Switches.
- D. ANSI/UL 498 - Attachment Plugs and Receptacles.
- E. ANSI/UL 943 - Ground Fault Circuit Interrupters.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts maximum).
- G. NEMA WD 1 - General-Purpose Wiring Devices.
- H. NEMA WD 5 - Specific-Purpose Wiring Devices.
- I. Texas Accessibility Standards. (TAS)

1.04 SUBMITTALS

- A. Provide submittals accordance and Division 01 for submittal requirement.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver wiring devices individually wrapped in factory-fabricated containers.
- B. Handle wiring devices carefully to avoid damage, breaking and scoring.
- C. Store in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.01 GENERAL

- A. 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. 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.
- B. Device color:
 - 1. Switches and receptacles on normal power shall be white.
 - 2. Switches and receptacles on emergency power shall be red.

2.02 WALL SWITCHES

- A. Acceptable manufacturers
 - 1. Arrow-Hart
 - 2. Hubbell
 - 3. General Electric
 - 4. Leviton

5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 260000 and Division 01 for substitution requirement.
- B. Material
1. Wall 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 volt AC with number of poles as required; Arrow-Hart 1990 Series.
 2. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120 volt AC with number of poles as required; Arrow-Hart 1990PL Series.
 3. A listed manual switch having a horsepower rating not less than the rating of the motor and marked "Suitable as Motor Disconnect" shall be permitted to serve as disconnect means for stationary motor of 2 horsepower or less.
 4. Switch terminal screws or connectors shall be designed to accommodate No. 10 solid conductor.

2.03 RECEPTACLES

- A. Acceptable manufacturers
1. Arrow-Hart
 2. Hubbell
 3. General Electric
 4. Leviton
 5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 260000 and Division 01 for substitution requirement.
- B. Material
1. Hospital grade receptacles shall be installed in corridors; Arrow-Hart 8200 Series.
 2. Dedicated circuit and convenience duplex receptacles shall be rated 20 amperes, 125 volt AC; Arrow-Hart 5362 Series.
 3. GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter; Arrow-Hart GF5342 Series.
 4. Receptacles within 6'-0" of sink or wet area shall be GFI type.
 5. All receptacles in restrooms, outdoors, and within 6' of a sink shall be GFI type.
 6. Circuit breakers serving vending machines, and EWCs shall be GFI (do not install GFI device at EWCs and vending machines).
 7. Specific-use receptacles shall have volts, amps, poles and NEMA configuration as noted on drawings.
 8. Heavy-duty lock-blade receptacles shall be NEMA WD5 heavy-duty specification grade.
 9. Provide combination receptacle/USB outlets as shown and detailed.
 10. Weatherproof receptacles as specified shall be mounted in a cast steel box with gasketed, weatherproof device plate as specified. Provide cast metal in-use cover where exposed to rain.

2.04 WALL PLATES

- A. Acceptable manufacturers
1. Arrow-Hart
 2. Hubbell
 3. General Electric
 4. Leviton
 5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 260000 and Division 01 for substitution requirement.
- B. Material
1. Wall plates shall be 316 or 302 stainless steel with cutouts as required for devices indicated on drawings, unless otherwise noted.

2. Where switches or outlets are shown adjacent to each other, they shall be ganged with partitions between different type services and covered by a single custom wall plate.
3. Exposed boxes:
 - a. Dry interior spaces: Use cast metal plates with cast metal box. Use heavy cadmium-plated sheet steel plates with steel boxes and copper-free aluminum with aluminum boxes. All screws shall be stainless steel. Edges of plates must be flush with edges of boxes.
 - b. Other locations: Use weatherproof devices plates. Provide cast metal plates with gasketed spring door
4. Jumbo plates are not permitted.
5. Weatherproof cover plate shall be gasketed cast aluminum or feraloy (by Crouse-Hinds) with hinged gasketed device covers (cast metal in-use cover where exposed to rain).

2.05 CUSTOM ENGRAVED COVER PLATES

- A. In all areas, provide custom engraved cover plate in accordance with Section 260553, Electrical Identification, on all receptacles, switches, and low voltage lighting control stations indicating panelboard and circuit number with 3/16-inch black letters/numbers.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Installer must examine the areas and conditions under which wiring devices are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 DEVICE COORDINATION

- A. Where items of equipment are provided under other sections of this specification or by the Owner, provide a compatible receptacle and/or device plate for the cap or plug, and cord of the equipment.

3.03 INSTALLATION

- A. General:
 1. Install wiring devices as indicated, in accordance with the applicable requirements of the latest release of NEC, NEMA, and ANSI.
 2. The approximate location of switches, power outlets, 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.
- B. Wall Switches and Lighting Control Stations:
 1. Location:
 - a. Install wall switches and lighting control stations in suitable outlet box centered at the height of 48-inches above finished floor, OFF position down.
 - b. Where wainscot occurs at the 48" level, install device in the wall below the wainscot and as near the 48" level as possible to provide the most pleasing appearance, but in no case partially in the wainscot and partially in the wall.
 - c. Where shown near doors, install devices not less than 2" and not more than 12" from door trim.
 - d. Verify all door swings before rough-in and locate devices on strike side of door as finally installed.

2. Position:
 - a. Wall switches: Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the project, generally up or to the left for the ON position.
- C. Receptacles:
 1. Location:
 - a. Install convenience outlets in suitable steel outlet boxes centered at the height of 18 inches above the finished floor, 6 inches above countertop or at the backsplash level, or as indicated on the drawings. Coordinate with equipment and architectural drawings.
 - b. Install receptacles generally where indicated on drawings. The Owner's representative reserves the right to make any reasonable changes in receptacle locations without change in the contract sum.
 - c. Install specific-use receptacles at heights shown on Drawings.
 2. Position:
 - a. Install receptacles vertically with ground pole on bottom. Install receptacles horizontally, where field condition does not allow vertical installation, with ground pole on left.
 3. Feed through to non-GFCI receptacles is not permitted.
- D. Plates:
 1. 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.
 2. All devices and cover plates shall be plumb and parallel to adjacent surfaces or trim. Devices must be flush with the finished trim cover plates and plates must be tight to surfaces over which they are installed.
 3. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, plates shall be labeled to identify items being controlled, or areas being lighted. Labeling shall be 3/16-inch Condensed Gothic and shall be filled with black enamel.

END OF SECTION

**SECTION 26 2813
FUSES, 600 VOLT**

PART 1 - GENERAL

1.01 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.

1.02 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.

1.03 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.

1.04 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 01 for submittal requirement.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Store fuses in a clean and dry space and protected from weather.

PART 2 - PRODUCTS

2.01 MATERIAL AND EQUIPMENT

- A. Furnish fuses manufactured by Buss, or equal, in accordance with the following:
 - 1. Motors, 0 to 600 Amp:
 - a. 250 volt - Buss LPN-RK, UL Class RK1.
- 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. Provide spare fuse cabinet and locate in main electrical room.

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 2816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Enclosures.

1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.04 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.05 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.01 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D
 - 2. Eaton
 - 3. Siemens
 - 4. GE/ABB
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 7. Service-Rated Switches: Labeled for use as service equipment.
 - 8. Accessory Control Power Voltage: As required.

2.02 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Square D
 - 2. Eaton
 - 3. Siemens
 - 4. GE/ABB
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: For frame sizes 250 amp and below, inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits and adjustable magnetic trip setting.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. 400 amp frame and above.
 - 2. Instantaneous trip.
 - 3. Long- and short-time pickup levels.
 - 4. Long- and short-time time adjustments.
- E. Current-Limiting Circuit Breakers: Frame sizes 600 amp and below.
- F. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.03 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 or Type 9.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.03 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study". Provide mission critical breakers or breakers with additional trip features as required for code required coordination.

END OF SECTION

**SECTION 26 5100
INTERIOR LIGHTING**

PART 1 - GENERAL

1.01 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.

1.02 WORK INCLUDED

- A. Interior lighting fixtures and accessories
- B. Exit lights
- C. LEDs
- D. Drivers
- E. Emergency lighting relays

1.03 REFERENCES

- A. NEPA 101 - Code for Safety to Life from Fire in Buildings and Structures
- B. NEMA WD1 - General-Purpose Wiring Devices
- C. UL 844 - Electric Lighting Fixtures for Use in hazardous (classified) Locations
- D. UL 924 - Emergency Lighting and Power Equipment
- E. IESNA - Lighting Handbook
- F. NEMA WD 1 - General Color Requirements for Wiring devices
- G. NFPA 70 - National Electrical Code
- H. IECC 2015 - International Energy Conservation Code

1.04 DESIGN CRITERIA

- A. Lighting level design shall be per IESNA (Illuminating Engineering Society of North America) recommendation.
- B. The power consumption for interior lighting shall not exceed power allowance as per 2018 IECC latest revision.

1.05 SUBMITTALS

- A. Provide submittals in accordance with and in addition to Section 260000, Basic Electrical Requirements, and Division 1 for submittal requirement.
- B. Submit manufacturer's data on interior 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 ratio, efficiency and visual comfort probability. Also provide luminaire weights, mounting data, and accessory information for each type.
- D. Submit point-by-point calculations for all interior spaces (two separate calculations).
 - 1. Normal + emergency
 - 2. Emergency
- E. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
- F. LEDs: Catalog cuts showing voltages, colors, approximate hours life, approximate initial lumens, and lumen maintenance curve.
- G. Drivers: Catalog cuts showing type, wiring diagram, nominal watts, input voltage, starting current, input watts, sound rating, power factor and low temperature characteristics.
- H. Shop drawings for site lighting luminaries showing pertinent physical characteristics, including fastening details, driver type and location.

- I. Controls: Catalog cuts and/or shop drawings showing dimensions, voltage capacity, contact ratings, wiring diagrams, operating levels, and temperature ratings.

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver lighting fixtures individually wrapped in factory-fabricated fiberboard type containers.
- 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 function 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 LEDs, reflectors, drivers, and wiring.

2.02 INTERIOR LIGHTING FIXTURES

- A. Lighting fixture housing shall be minimum 22-gauge, cold-rolled steel with pre-punched knockouts and access plate for electrical connections. End plates shall be minimum 20-gauge with pre-punched hanger holes. Driver mounts shall be separated for heat dissipation.
- B. UL Listing
 1. All Luminaires and components shall be UL tested, listed, and labeled.
 2. Luminaires installed in damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.
 3. Recessed luminaires 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 LEDS

- A. All LED luminaires shall be UL Listed and be furnished complete with LEDs and Power supplies at locations indicated on the drawings. Each fixture shall bear the UL Label and shall comply with Code Requirements.
- B. Luminaires shall meet the US Department of Energy's Energy Star performance criteria.
- C. LED luminaires shall be designed with heat sinking adequate such that the junction temperature of the LEDs is maintained to meet the rated life as published by the LED manufacturer. Luminaire manufacturer shall provide validation documentation. Heat sinking shall not become compromised with time, lack of maintenance, and/or vibration resistance so that the heat-sink does not become detached from the LED PCB.
- D. The LED luminaires shall have a complete 5 year warranty from date of installation
- E. The LED luminaires shall be UL, or ETL listed and be furnished complete with LEDs and power supplies.

- F. LED power supplies shall operate LEDs within the current limit specification of the manufacturer
- G. Shall operate from 60Hz or 50Hz input source and have input power factor above 90% and a minimum efficiency of 70-% at full rated load of the driver.
- H. Shall have short circuit and overload protection.
- I. Shall have a minimum starting temperature of 0°F and a maximum case temperature rating of at least 70°C.
- J. Power supply output shall be regulated to +/-5% across published load range.
- K. Shall have a Class A sound rating.
- L. Shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI.
- M. Shall have a 5 year warranty from date of manufacturer against defects in material or workmanship, including a replacement, for operation at or below the maximum case temperature specification.
- N. Manufacturer shall have a 15 year history of producing power supplies for the North American market.
- O. Dimmable power supplies shall be controlled by a (DC 0-10V Device/AC forward-phase control device/AC reverse phase control device) and shall be capable of operating, flicker-free, from 100-1% dimming range.
 - 1. Dimmable power supplies shall allow the light output to be maintained at the lowest control setting (prior to off) without dropping out.
 - 2. Shall be compatible with lighting control systems procured on the project.
- P. All LEDs shall have a color temperature as noted on drawings with CRI ≥80 unless noted otherwise on drawings. Confirm color temperature and CRI at time of preparing submittals.
- Q. L70 rated life shall be a minimum of 50,000 hours.
- R. All LED modules, unless noted otherwise, shall be provided by the light fixture manufacturer and integral to the luminaire.
- S. LED modules/arrays shall be replaceable in the field. If luminaires are still under warranty, the Owner shall be compensated for the labor to do replacement work or the manufacturer shall send a factory representative to the site to do the work.
- T. Replacement modules should have the ability to be “tuned” to match the output of remaining adjacent luminaires in the event that some time has passed and there has been light loss.

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 trim, frames, color, mounting, driver, 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 applicable requirements of NEC, and national and local codes, standards, and regulations.
- B. Install luminaries at locations as shown on the Drawings; install 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 Fixtures:
 - 1. Fixtures shall be supported from structure at four points near each corner of fixtures.
- 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 LEDs 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. Lighting Fixtures Adjustment
 - 1. Adjust to illuminate intended areas as directed.
- G. 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 test all fixtures for electrical as well as mechanical operation.
- H. Protect installed fixtures from damage during the remainder of the construction period.
- I. 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 0500
COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Uniform General Conditions, Supplementary General Conditions, and Division 1 General Requirements apply to this Section.
- B. Section includes project description, definitions, references, contractor qualifications, supervision, equipment and materials, minimum requirements, workmanship, warranty, coordination drawings, storage and protection of materials, cutting and Patching, concealment, rough-in, and submittals.
- C. Each Section following, including this, is an integrated part of a whole. No section shall be issued alone. Parts 1 and 2 of each Section may contain descriptions of general information and approved materials that are typically used industry-wide but are not specifically part of this project. Part 3 - Execution of each Section, together with the drawings, identifies the installation procedures for components included in this project. A brief synopsis of the work included in this project also follows below in Section 1.3.
- D. The work covered by the communications specifications shall include furnishing all materials, labor, transportation, tools, permits, fees, utilities, and incidentals necessary for the complete installation of all communications work required in the contract documents and specified herein. The contract documents intend to provide complete installation in every respect. If additional details or special construction may be required for the work indicated or specified in this Section or work specified in other sections, the Contractor shall be responsible for providing all material and labor to make the installation complete and operative.
- E. All phases of work shall be sequenced under Section 01110, and the Contractor shall be responsible for the coordination and proper relation of his work to the building structure and other trades. Before the installation, the Contractor shall provide detailed plans showing the coordination of pathways and termination equipment with Mechanical, Plumbing, and Electrical drawings. Voice and Data Communications systems shall be independent of any other systems.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - A. 270500 Common Work Results
 - B. 270526 Grounding and Bonding
 - C. 270528 Pathways for Communications Systems
 - D. 270553 Identification for Communications Systems
 - E. 271100 Communications Equipment Room Fittings
 - F. 271500 Communications Horizontal Cabling
 - G. 271600 Patch Cords, Station Cords, & Cross-Connect Wire
 - H. 272000 Data Communications Equipment
 - I. 273000 Voice Communications Equipment
 - J. 274000 Audiovisual System

1.3 REFERENCES

- A. Codes and Standards (Latest issue and addenda)
1. ADA Standards for Accessible Design 28 CFR Part 36
 2. U.S. Department of Labor Occupational Safety & Health Administration (OSHA)
 3. UNT Telecommunications and Infrastructure Requirements
 4. BICSI TDM 11th Edition
 5. National Electric Code (NEC), Latest Issue
 6. ANSI/TIA568-C.1 - Commercial Building Telecommunications Cabling Standard*
 7. ANSI/TIA568-C.2 - Commercial Building Telecommunications Cabling Standard*
 8. ANSI/TIA568-C.3 - Optical Fiber Cabling Components Standard*
 9. ANSI/TIA569-C - Commercial Building Standard for Telecommunications Pathways and Spaces*
 10. ANSI/TIA 606-B - Administration Standard for Commercial Telecommunications Infrastructures, June 21, 2002*
 11. ANSI J-STD-607-A, Commercial Building. Grounding/Bonding Requirements- Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002*
 12. ANSI/TIA758-B - Customer-owned Outside Plant Telecommunications Infrastructure Standard, May 2005*
 13. International Standards Organization/International Electrotechnical Commission (ISO/IEC) IS 11801, 2000*
 14. Underwriters Laboratories (UL) Cable Certification and Follow-Up Program*
 15. National Electrical Manufacturers Association (NEMA)*
 16. American Society for Testing Materials (ASTM)*
 17. American National Standards Institute (ANSI), ANSI T1.404 (DS3) and CATV Applications
 18. Institute of Electrical And Electronics Engineers (IEEE), IEEE 802.4 Broadband Applications and 802.7 Broadband Specifications Standard
 19. Federal Communications Commission (FCC), FCC Part 15 and FCC Part 76
 20. National Cable Television Association (NCTA), NCTA-02.
- B. Acronyms and Abbreviations
1. ADA Americans with Disabilities Act
 2. AKA Also Known As
 3. ANSI American National Standards Institute
 4. AP Access Provider
 5. ASTM American Society for Testing and Materials
 6. AWG American Wire Gauge
 7. BICSI Building Industry Consulting Services International
 8. CATV Community antenna television
 9. CO-OSP customer-owned outside plant
 10. EF Entrance facility
 11. EIA Electronic Industries Alliance
 12. EMI Electromagnetic interference
 13. FCC Federal Communications Commission
 14. HVAC heating, ventilation, and air conditioning
 15. IEEE The Institute of Electrical and Electronics Engineers
 16. ITS Information Technology System
 17. ISO International Organization for Standardization
 18. LAN local area network
 19. Mb/s megabits per second
 20. MC main cross-connect, AKA Main Distribution Frame (MDF)
 21. MDF main distribution frame, AKA main cross-connect (MC)
 22. NEMA National Electrical Manufacturers Association

23.	NESCO	National Electrical Safety Code
24.	NFPA	National Fire Protection Association
25.	OFOI	Owner Furnished Owner Installed
26.	RCDD	Registered Communications Distribution Designer
27.	SCS	Structured Cabling System
28.	TBB	Telecommunications bonding backbone
29.	TR	Telecommunications room, AKA Intermediate Distribution Frame (IDF)
30.	TGB	Telecommunications grounding busbar
31.	TMGB	Telecommunications main grounding busbar
32.	TIA	Telecommunications Industry Association
33.	UL	Underwriters Laboratories
34.	UTP	Unshielded twisted-pair
35.	WA	Work area
36.	WAP	wireless access points
37.	X	cross-connect

1.4 PROPOSAL SUBMITTALS

- A. See Section 01-30-00 - Administrative Requirements for submittal procedures.
- B. Follow Division 1 and this Section. All submittals shall be reviewed and stamped by the Contractor's project RCDD.
- C. Submit a resume and copy of the Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for the Contractor's project RCDD.
- D. A list of technical product education (training) completed by the Contractor's project personnel.
- E. All installation team members must be certified by the Manufacturer as having completed the necessary training to complete their part of the installation. Submit resumes of the entire team, completed training courses, and copies of BICSI Installer certificates TE300, training course IN100, and IN200.
- F. Cable tester manufacturer or a third-party certification for copper and fiber cable test technicians.
- G. Price Quotation Information -
 - 1. Itemized Unit Pricing for Labor and Material;
 - 2. Itemized Add/Deduct Unit Pricing for Labor and Material for Pre- Cutover (200' average length) ONE (1) CAT 6 Drop;
 - 3. Itemized Add/Deduct Unit Pricing for Labor and Material for Post-Cutover (200' average length) ONE (1) CAT 6 Drop;
 - 4. Itemized Add/Deduct Unit Pricing for Labor and Material for Pre-Cutover (200' average length) TWO (2) CAT 6 Drop;
 - 5. Itemized Add/Deduct Unit Pricing for Labor and Material for Post-Cutover (200' average length) TWO (2) CAT 6 Drop;
 - 6. Itemized Add/Deduct Unit Pricing for Labor and Material for Pre- Cutover (200' average length) FOUR (4) CAT 6 Drop;
 - 7. Itemized Add/Deduct Unit Pricing for Labor and Material for Post-Cutover (200' average length) FOUR (4) CAT 6 Drop;
- E. The Contractor shall review paragraph 1.3 of this Section; Codes and Standards - Latest issue and addendums and state understanding and compliance or exception.

- F. Product Data: For each type of product indicated below. Product data to include, but not limited to, materials, finishes, approvals, load ratings, and dimensional information.
 - 1. Submittals shall include the manufacturer cut sheets for the following:
 - a. Equipment enclosures and/or racks;
 - b. Fiber optic and balanced twisted pair cable;
 - c. Patch cords and cross-connect media;
 - d. Connectors and termination hardware;
 - e. Protection hardware;
 - f. Fire-stopping materials;
 - g. Test equipment to be used for fiber and balanced twisted pair channels;
 - h. Cable tray and cable support hardware.
- G. Product Data Manufactures literature sheets for all materials and equipment, including a copy of the proposed warranty, recommended preventative maintenance, and spare part inventory recommendations. Literature containing more than one device shall be marked to delineate the item(s) included in the work. Indicate color or special finishes.
- H. Manufacturer and Contractor statement of RoHS: Restriction of Certain Hazardous Substances Compliance.
- I. Design and Installation Certificates: The local cable manufacturer's representative signifies that the design is acceptable to the cable manufacturer's Design Engineer(s) and that the manufacturer authorizes the Contractor to install a registered (warranty) cabling system.

1.5 DESCRIPTION OF PROJECT

- A. Intermediate Distribution Frame (IDF) – Located on Level 1 of the Facility.
- B. Pathways - The electrical Contractor will install conduits. One (1) 1" EMT conduit will be placed from each communications device outlet into the ceiling spaces and terminate within 6" above the nearest cable tray where practical. The conduit will be attached to the underside of the ceiling structure above the ceiling, and the cable tray, and a bushing-type coupler will be included at the connection point. All conduit stub-ups will be terminated above into accessible ceiling spaces. Cabling, not in conduit or cable tray placed above the ceiling in the Chilton Hall Building, will be supported on 48" maximum centers using J-hooks (see Section 270528).
- C. Horizontal cabling – Typical Data Outlet will consist of two (2) Data Cables. All horizontal cabling shall be plenum-rated.
- D. Equipment Racks - All cabling shall be terminated to patch panels (data) mounted to 19" x7'0" floor-mounted equipment racks in the TR. Refer to Telecommunications Detail Drawings for specifics. Section 271100 establishes the requirements for the communications racks.

1.6 SUBMITTALS FOR PROJECT RECORD

- A. Follow Division 1 and this Section.
 - 1. Drawings: As-built Documentation must be submitted five (5) business days before obtaining approval for cutover to any portion of the new cable plant system. Furnish for review and comments four complete sets of E size (30 by 42), four complete sets of C size as-built drawings, and 4 CDs containing all electronic AutoCAD 2000 or newer (DWG) files.
 - 2. Final approved Shop Drawings: Include plan and elevation of TRs, cable pathway details, cable locations, and cable ID#.

3. 4 sets of cable inventory data must be submitted for all copper and fiber termination hardware (before cutover to the new cable plant if applicable.) Submit data in binders and electronically on CDs in "Microsoft Excel " format, listing products furnished, including:
 - a. Manufacturer's name and part numbers.
 - b. Cable numbers utilizing the Owner's cable numbering standard.
 - c. Location and riser assignments.
4. Manufacturer Certificates: Within ten days of completion of the project, the Contractor shall deliver a letter signed by local Structured Cabling Components representatives and the Contractor's RCDD stating that the installed cabling system complies with all requirements specified in manufacturer's installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.
5. Test Reports: 4 sets of hard copies with four copies on CD in compliance with related Test Result Documentation.
6. Submitted test results and non-compliant submittals will be reviewed and returned to the Contractor with comments.
7. Re-submitted test results and non-compliant submittals will be reviewed and returned to the Contractor with comments.
8. Manufacturer's warranty to the Owner. This shall include, but not be limited to, the owner's name and the project name and address. (Within three weeks of substantial completion).
9. Within ten days of completion of the project, the Contractor shall deliver a letter signed by a local SCS Manufacturers representative and Contractor's RCDD stating that the installed cabling system complies with all requirements specified in installation guidelines and that there were no accidents, improper installation, mishandling, misuse, damage while in transit, unauthorized alteration, unauthorized repair, failure to follow instructions, or misuse with the structured cabling system that could adversely impact warranty.
10. Within 30 days of completion of a project, the communications contractor and/or the manufacturer's local representative will provide the owner with The Structured Cabling Performance Warranty signed by the manufacturer. The warranty shall list the owner and name of the Facility, including location, as the holder of the warranty.

1.7 DEFINITIONS

- A. MER - Main Equipment Room: The main room typically contains the PBX, MDF, and main Data Communications equipment.
- B. TR - Telecommunications Room: Any additional room that contains switches, hubs, patch panels, and cross-connects away from a central location to serve areas out of distance from the MER.
- C. TO - Telecommunications Outlet: Point of connectivity for voice, data, or video on the wall or the floor. Refer to Telecommunications Drawings and Symbol sheet(s) for quantities and media types at each outlet.
- D. MDF - Main Distribution Frame: A termination frame for unshielded twisted pair cable, usually providing a connection field for PBX telephone ports and feeder/riser cables to TRs. The MDF is normally located in the MER.
- E. IDF - Intermediate Distribution Frame: A termination frame for unshielded twisted pair cabling providing a connection field for horizontal wiring from the workstation and feeder/riser cables

extended from the MER.

- F. PBX - Private Branch Exchange: Privately owned voice communications switch.
- G. STUBBED OUTLET - A flush device box, 4-11/16" x 4-11/16" x 2-1/8" deep, with a single-gang extension ring installed behind sheet-rock walls or within concrete block walls. There shall be two (2) conduits a minimum of 1" installed to each device box (See drawing T3.03.05). The device box is centered at 18" AFF, and the conduit(s) rise to a point above the suspended ceiling or continue to an accessible ceiling for cable installation. The electrical Contractor provides this work.
- H. PROJECT MANAGER - An individual who manages the logistic requirements of projects, such as personnel, material, and schedules. This individual may be responsible for multiple projects.
- I. SUPERVISOR - An individual responsible for a specific project and is on-site for 95% of the workday. This individual manages personnel assigned to the project, ensures that materials are ordered, received, and installed on time, and ensures the overall quality of the project. This individual must be a Registered Communications Distribution Designer in good standing with BICSI. Successful completion of the BICSI IST100 training course in addition to TE300 is required.
- J. LEAD TECHNICIAN - An individual in charge of up to 4 technicians. This individual is responsible for timely project completion and quality assurance. Completing the BICSI TE300 training course and all its prerequisites is required.
- K. TECHNICIAN, LEVEL II (Installer, Level 2) - An individual who possesses the training and skills necessary to qualify for and has successfully passed the BICSI IN200 training course requirements. This individual is responsible for his or her work plus the work of not more than one (1) level 1 installer.
- L. TECHNICIAN, LEVEL I (Installer, Level 1) - An individual who possesses the training and skills necessary to qualify for and has successfully passed the BICSI IN100 training course requirements.

1.8 CONTRACTOR QUALIFICATIONS

- A. General Qualifications
 - 1. This Division 27 Communications vendor will be a Panduit Platinum partner and Corning certified and will be responsible for all cabling, fiber, J-hooks, voice and data jacks and faceplates, wireless access point (WAP) installation, patch cords, racks, ladder rack, vertical/horizontal wire managers, and patch panels.
 - 2. Untrained, undocumented, or otherwise unqualified personnel cannot perform any portion of the communications infrastructure installation.
 - 3. All personnel must be permanent employees of the telecommunications contractor or approved sub-contractors.
- B. Voice/Data
 - 1. The Contractor shall have been in the telecommunications business continually for at least five years.
 - 2. A minimum of five (5) representative educational facilities projects must be submitted as references to include the school's name, address, Architect or Engineer, cost of the project, and the contact person at the school district, including phone number.
 - 3. The Telecommunications contractor shall own and possess at least one copy of ANSI/TIA Telecommunications Building Wiring Standards, latest issue. Available from

Global Engineering Documents, telephone (800) 624-3974, and the internet address www.global.ihs.com.

4. The Telecommunications contractor shall own and possess at least one copy of the BICSI Telecommunications Distribution Methods Manual, latest issue, available from BICSI (Building Industry Consulting Services International) telephone (800) 242-7405, internet address www.bicsi.org.
 5. The telecommunications contractor shall possess current certifications from Panduit/Corning.
 6. All project managers, supervisors, lead technicians, and technicians for the telecommunications contractor shall each possess individual certification(s) for installing and testing Panduit/Corning voice/data and fiber optic cabling products.
 7. Supervisor(s) shall possess BICSI certificates of completion for training courses IS100 and TE300.
 8. Strongly Recommended: Lead Technicians shall possess BICSI certificates of completion for the training course TE300.
 9. Strongly Recommended: Technicians shall possess BICSI certificates of completion for the training courses IN200 or IN100 for Installer Level 2 or Installer Level 1.
- C. Audio/Video
1. Five (5) years of experience installing broadband distribution systems, including splicing, terminating, and testing copper coaxial cable.
 2. Five (5) installed systems, comparable to the Owner's installation, where broadband distribution systems are installed, and the systems have been in continuous satisfactory operation for at least one (1) year. The Contractor shall submit as proof supporting documents and the names, addresses, and telephone numbers of the operating personnel who can be contacted regarding the installed systems.
 3. A minimum of five (5) representative educational facilities projects must be submitted as references to include the school's name, address, Architect or Engineer, cost of the project, and the contact person at the school district, including phone number.
 4. Installers must have been trained and experienced in the specific splicing, terminating, and testing equipment for installation. The Contractor shall possess all relevant certifications required by the manufacturer before installing the manufacturer's specific products. The Contractor shall provide a list of their technical support staff, work experience, training history, and manufacturer's certification.
 5. Qualified Contractors shall submit proof of all certifications and experience details with a bid response.

1.9 SUPERVISION

- A. All work performed under Division 27 shall be continuously supervised at the project site by a Registered Communications Distribution Designer (RCDD) in good standing with Building Industry Consulting Service International (BICSI).
- B. The Project Manager shall be the main point of contact for the project between the Owner and the Owner's assignee.
- C. The Contractor's Project Manager shall attend a pre-installation meeting with the Owner and design team before working on the project.
- D. The site supervisor shall be assigned to the project site for 95% of the work week and shall be responsible for managing Lead Technicians.
- E. The Lead Technician shall be responsible for the direct supervision of not more than four (4) total Technicians, either Level II or Level 1.

- F. A Technician, Level II shall be directly responsible for not more than one (1) Technician, Level 1.

1.10 EQUIPMENT AND MATERIALS MINIMUM REQUIREMENTS

- A. All wiring, materials, and equipment must be listed and labeled by a nationally recognized testing laboratory.
- B. Original Equipment Manufacturer (OEM) documentation must be provided to the Owner's Telecommunications Technical Representative, who certifies performance characteristics that meet TIA standards.
- C. The Contractor shall structure and equip the cable and wire system to minimize vulnerability to single points of failure.
- D. All parts shall be made of corrosion-resistant materials, such as plastic, anodized aluminum, or brass.
- E. All materials used in the installation shall be resistant to fungus growth and moisture deterioration.
- F. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the specified environmental operating conditions.
- G. The Contractor shall ensure that the wire and cable allow detection and diagnosis of problems to achieve high reliability and availability.
- H. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the Manufacturer.
- I. Firestop all rated wall penetrations according to code requirements and industry standards.

1.11 WORKMANSHIP

- A. All work shall be performed in a neat, workmanlike manner.
- B. Cable trunks (bundles) shall be routed along or perpendicular to building lines.
- C. Cable trunks shall be placed above installation-convenient pathways such as hallways.

1.12 WARRANTY

- A. The Contractor and Manufacturers shall provide a TWO (2) YEAR guarantee for all work under the Telecommunications Trade. However, such guarantees shall be in addition to and not in place of all other liabilities that the Manufacturer and Contractor may have by law or other provisions of the Contract Documents. In any case, such guarantees and warranties shall commence when the Owner accepts the telecommunications system, as the Engineer determines. They shall remain in effect for TWO (2) YEARS after that.
- B. All materials, items of equipment, and workmanship furnished under each Section shall carry a TWO (2) YEAR warranty against all defects in material and workmanship. Any fault under any Contract due to defective or improper material, equipment, workmanship, or design which may

develop shall be made good, forthwith, by and at the expense of the Contractor for the work under his Contract, including all other damage done to areas, materials, and other systems resulting from this failure.

- C. The Contractor shall guarantee that all elements of the system, which are to be provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.
- D. Upon receipt of notice from the Owner of the failure of any part of any systems or equipment during the guarantee period, the Contractor shall replace the affected part or parts for his respective work, as applicable.
- E. An additional extended warranty is required for work on this project. The additions and/or extensions to the standard year guarantee previously described are to be provided in writing by the Manufacturers. The warranty is to cover all parts and labor as specified below:
 - 1. Certified Panduit 25-year performance certification for:
 - a. Category 6A, horizontal and backbone copper cable and associated labor.
 - b. Category 6A, patch panels, blocks, and associated labor.
 - c. Category 6A, data workstation outlets and associated labor.
- F. Furnish, before the final payment is made, a written guarantee covering the above requirements.
- G. Additional/extended warranty listed above is Non-negotiable and cannot be amended through the submittal process.

1.13 COORDINATION DRAWINGS

- A. It shall be the Contractor's responsibility to consult the Architectural and Engineering Drawings and Details, thoroughly familiarizing himself with the type and quality of construction to be provided on this project.
- B. The Telecommunications Drawings are diagrammatic in character and cannot show every connection in detail or every line or conduit in its exact location. These details are subject to the requirements of local ordinances and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and coordinate with all other trades to avoid interference between the various phases of work.
- C. The approximate location of Telecommunications items is indicated on the Telecommunications Drawings. These drawings are not intended to give complete and exact details regarding the location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the job site and will, in all cases, be subject to the approval of the Architect. The Architect reserves the right to make reasonable changes in the location indicated without additional cost.

1.14 STORAGE AND PROTECTION OF MATERIALS

- A. Wiring, materials, and equipment shall be delivered and stored in a clean, dry space.
- B. All materials shall be properly packaged in factory-fabricated containers and protected from

damaging fumes, construction debris, and traffic until job completion.

- C. Refer to Division 1 for additional information.

1.15 CUTTING AND PATCHING

- A. Where it becomes necessary to cut through any wall, floor, or ceiling to install any work under this Section of the Contract or to repair any defects that may appear up to the expiration of the guarantee period, such cutting shall be done under the supervision of the Architect/Engineer by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect/Engineer.
- B. Patching of all openings cut by the Contractor or repairing any damage to the work of other trades caused by cutting or failure of any part of the work installed under this Contract shall be performed by the appropriate trade. Still, it shall be paid for by the Contractor.
- C. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills at locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer.
- D. All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved and shall match the remaining surrounding materials and/or finishes.
- E. Coring through slabs after concrete placement requires an X-ray to verify rebar location before coring. The Contractor shall bear all costs associated with coring, including but not limited to coring and X-ray inspection. The core drill shall not cut any rebar.
- F. Refer to Division 1 for additional information.

1.16 CONCEALMENT

- A. No telecommunications cable or cable tray may be installed where physical access is not attainable.
- B. If cable and/or cable tray pass through areas obstructed by sheet-rocked ceilings and/or fire-rated walls or exceeds 20' over a solid sheet-rocked ceiling area, access panels must be installed.
- C. The Contractor shall determine whether access panels are required by investigating the architectural drawings for this Contract. The Contractor shall also bear the cost of installation of any access panels.

1.17 ROUGH-IN

- A. "Rough-in" shall be defined as incomplete cable or equipment installation.
- B. Where cable is to be roughed in, the following conditions shall be met:
 - 1. Cables shall be run within active cabling bundles and dressed out the same.
 - 2. Where cables are routed into stub-outs, at least 18" of the cable shall be left coiled within the device box. The device box shall have an appropriate blank cover plate installed.

3. Where no stubbed-out pathways are provided, leave roughed-in cables coiled near the center of the growth area with enough slack to reach the floor plus any place in the area and a minimum of 15' for service loop.

Cables not to be terminated at patch panels in an MTR or TR shall be left coiled in the ceiling of the MTR or TR with enough slack to reach the floor plus across the MTR or TR to the opposite wall.

1.18 DOCUMENTATION

- A. Documentation shall be provided in the form of as-built drawings, cable test records, and O&M Manuals.
- B. Refer to Section 01330 Submittals Procedures
- C. Refer to Section 01340 Shop Drawings, Product Data, and Samples

1.19 SUBMITTALS

- A. Refer to Section 01340 - Shop Drawings, Product Data, Samples, and Colors.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Substitutions: See Section 01-60-00 - Product Requirements.
- B. Special Note: UNT is a Panduit/Corning-specific location and has requested that the Panduit 25-year Warranty be extended to this installation. This requires that:
 1. The installer of the telecommunications infrastructure should be Panduit Platinum and Corning certified.
 2. Panduit must manufacture the jack inserts, patch panels, and accessories.
 3. Panduit must manufacture Category 6 and Category 6A cable.
 4. The project shall be registered for warranty, and test data shall be submitted for acceptance by Panduit.

PART 3 EXECUTION

3.1 CABLE CONTRACTORS

- A. Cable Contractor Qualifications
 1. The Cable Contractor shall have a workers' compensation experience modification rating (EMR) of less than 1.0.
 2. The full-time on-site supervisor shall be certified by the Manufacturer of the products being installed.
 3. The Cable Contractor shall have installed similar systems in at least one similar project in the year prior to this bid and be regularly engaged in installing the types of systems specified in this document. The Cable Contractor shall provide the names and locations of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.

4. The Cable Contractor shall have a minimum of one (1) full-time employee on staff who is a BICSI RCDD with experience in similar projects to review and approve the design and construction plans, inspect work, and report status weekly.
5. The Cable Contractor's personnel shall have a complete working knowledge of low voltage cabling applications such as, but not limited to, data, voice, video, and audiovisual network systems.
6. Untrained or otherwise unqualified personnel cannot perform any portion of the communications infrastructure installation.
7. The Cable Contractor's personnel must be permanent employees of the Cable Contractor or approved sub-contractors.
8. The Cable Contractor shall review paragraph 1.5 B Codes and Standards - Latest issue and addendums (of this Section) and state compliance or exception to any code or standard.
9. The Cable Contractor shall have been in the telecommunications cabling business for at least four years.
10. Eighty percent (80%) of Cable Contractors' personnel shall have at least three years of experience installing the types of systems, equipment, and cables specified in this document.
11. Fifty percent (50%) of Cable Contractors' personnel shall be certified by the specified manufacturer(s) for Telecommunication cabling installations and maintenance of the listed products.

3.2 SUBMITTALS

- A. Provide a copy of the supervising Registered Communications Distribution Designer's current certificate.
- B. Provide a copy of the proposed manufacturer's extended warranty.
- C. Provide copies of resumes for each technician, lead technician, supervisor, and project manager. Each individual's training certificates shall accompany each resume.
- D. Provide proof of ownership of the ANSI/TIA-568 standards, latest issue.
- E. Provide proof of ownership of the Telecommunications Standards and Methods Manuals, eleventh edition.
- F. Submit proposed Television Broadband Distribution System equipment and cable plant layouts, including equipment rack layouts, system schematics, and riser diagrams. All equipment, expected signal levels, and equipment signal level values must be shown.
- G. Submit records of Category 6 Cable Certification tests at the time of substantial completion.
- H. Submit records of fiber optic power Meters and OTDR (Tier Two) cable certification tests at the time of substantial completion.

3.3 RECORD DOCUMENTS

- A. Maintain Project Record documents weekly.
- B. Refer to Section 01780 Closeout Submittals for dispensation of all record Documentation.
- C. Refer to Section 270553 Identification for Telecommunications Systems for details on Closeout Submittals required for warranty certification.

END OF SECTION 270500

**SECTION 27 0528
PATHWAYS FOR COMMUNICATIONS SYSTEMS**

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 specifies the Pathways for Communications Systems requirements for the University of North Texas –Chilton Hall Renovation in Denton, Texas.
- B. Communication Pathways are defined to include, but are not limited to, inner duct, conduit, pull boxes, sleeves, cable trays, support, accessories, associated hardware, and fire-stopping materials. The Electrical Engineer of Record shall make the final design and specifications for conduits.
- C. The primary horizontal cable support system will be an existing. The cable tray will be properly grounded. Wall penetrations shall transition to properly fire-stopped 4" sleeves, then back to the cable tray.
- D. Outlets having one single cable require a single gang box that stubs up into the accessible ceiling void via one (1) 1" conduit with a pull string.
- E. Outlets with two or more cables require a double gang box with a single gang reducer that stubs into the accessible ceiling void via one (1) 1" conduit with a pull string.
- F. Conduit runs may not be longer than 100ft or have more than two 90-degree bends without using an adequately sized junction box. Insulated throat compression fittings must be used for communications conduit runs, with termination points installed with plastic or grounding bushings.
- G. Riser sleeve in ER/TRs must be installed appropriately with bushings and fire-stop.
- H. Cables shall be neatly dressed along common paths with Velcro tie wraps and voice cables separated from data cables. Maximum number of cables per bundle shall not exceed manufacturer specifications.
- I. The layout cable pathway runs in advance to determine space requirements along pathways and ensure non-interference with other trade installations.
- J. Do not support communication pathway from or lay on a ceiling suspension system or use electrical, plumbing, or other pipes for support. Communication pathway supports shall be permanently anchored to the building structure or joist. Provide attachment hardware and anchors designed for the structure to which they are attached and suitably sized to carry the weight of the pathway and support the cables. Confirm installation procedures for the cable support system with the architect and/or construction manager before implementation.
- K. Work furnished and installed by the Electrical Contractor as specified in this Section and as shown in E and T drawings includes:
 - 1. The conduits and back boxes for the work area telecommunications outlets.
 - 2. Fire stopping of cable tray and conduit cable pathway.
- L. Work furnished and installed by the Cable Contractor as specified in this Section and as shown in E and T drawings includes:
 - 1. All j-hook pathways.

2. Bonding and grounding of overhead cable runway system (ladder rack), racks, and cabinets within the ER/TR.
3. Fire stopping of conduit sleeves.

PART 2 – PRODUCTS

2.1 CABLE HOOK SYSTEMS

- A. J-hooks should be installed 4ft to 5ft apart. Uniform spacing should be avoided to minimize problems with signal degradation.
- B. J-hooks should be supported from decking or building structures using methods approved by the manufacturer.
- C. The cable count should not exceed the manufacturer's recommended maximum. Add a separate parallel J-hook pathway should cable count require it.
- D. Acceptable Manufacturers:
 1. Panduit

2.2 CONDUITS AND FITTINGS

- A. For each communication outlet 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.
- B. See SECTION 260533 - RACEWAYS, CONDUITS AND BOXES
- C. Minimum conduit size for Telecommunications Outlets shall be 1 (one) inch.

2.3 WALL AND CEILING OUTLET BOXES

- A. All wall outlets shall be mounted in a minimum of four (4) inches by four (4) inches by two and one-half (2 1/2) inches deep double gang outlet box with a single gang mud-ring.
- B. 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. See SECTION 260533 - RACEWAYS, CONDUITS AND BOXES.

2.4 PULL AND JUNCTION BOXES

- A. Pull boxes used with telecommunications conduits in interior locations shall be rated NEMA- 1. Pull boxes used in damp or wet locations such as plumbing chases or out-of-doors shall be rated NEMA-3R. Pull boxes shall be installed in conduits run at an interval no greater than every 100 feet. A pull box shall be installed in conduit runs whenever there are two 90°sweeps, or a total of 180°of sweeps, in a conduit run. A pull box may not be used to change the direction of a conduit run. Any deviations from these criteria must have prior approval from UNT IT.
- B. See SECTION 260533 - RACEWAYS, CONDUITS AND BOXES

2.5 PLENUM-RATED FIBER OPTIC INNERDUCT

- A. All fiber shall be installed in 1 ¼" corrugated, non-metallic plenum-rated innerduct when not installed in conduit or in a utility tunnel tray.
 - 1. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.
 - 2. Only the manufacturer's fittings, transition adapters, terminators, and fixed bends shall be used.
- B. Products
 - 1. White or orange, plenum-rated, UL-listed, flexible optical fiber/communication raceway.
 - 2. Recognized per NEC Articles 770 and 800 for plenum areas for optical fiber and telecommunications cables.
 - 3. Provide all fittings to form a complete integrated raceway system.
- C. Fabrication
 - 1. Footage shall be sequentially marked.

2.6 CABLE TRAY SECTIONS AND COMPONENTS

- A. General: Except as otherwise indicated, provide metal cable trays of types, classes, and sizes indicated, with splice plates, bolts, nuts, and washers for connecting units. Construct units with rounded edges and smooth surfaces in compliance with applicable standards and with the following additional construction features.
- B. Tray Sizes shall have a 4-inch minimum usable load depth, or as noted on the drawing.
- C. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 12-foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
- D. Tray widths shall be 18 inches or as shown on drawings.
- E. All fittings must have a minimum radius of 24 inches.
- F. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of the tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing the rated loading capacity of the cable tray.
- G. Cable Tray Supports: Shall be placed so that the support spans do not exceed the maximum span indicated on drawings. Supports shall be constructed from 12-gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits (9G-55XX-22SH) as manufactured by Cooper B-Line, Inc. [or engineer approved equal]. Cable trays installed adjacent to walls shall be supported on wall-mounted brackets such as B409 as manufactured by Cooper B-Line, Inc. [or engineer-approved equal].
- H. Trapeze hangers shall be supported by 1/2-inch (minimum) diameter rods.
- I. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.
- J. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

2.7 FIRE RATED WIRING DEVICES

- A. Wiring Devices:

1. Cables passing through fire-rated floors or walls shall pass through fire-rated wiring devices containing an intumescent insert material that adjusts automatically to cable additions or subtractions.
 2. The device shall have an F Rating equal to the rating of the barrier in which the device is installed.
 3. Wiring devices shall be capable of allowing a 0 to 100-percent visual fill of cables.
 4. Wire devices shall be of sufficient size to accommodate the quantity and size of electrical wires and data cables required.
 5. Wire devices to be provided with steel wall plates allowing for single or multiple devices to be ganged together.
- B. Acceptable Manufacturers:
1. Specified Technologies Inc.
 2. EZ-PATH Fire Rated Pathway
 3. 3M

PART 3 – EXECUTION

3.1 GENERAL

- A. Where conduit, pull boxes, cable tray, and other raceway sizes are not explicitly shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC. No conduit shall be less than 1".
- B. Conduits must be designed and installed on the most direct route possible from the telecommunications room to the work area.
- C. All conduit ends shall have plastic bushings installed before the cable is pulled into the conduit.
- D. Conduits will not be run next to hot water lines, steam pipes, or other utilities that may present a safety hazard or cause system performance degradation.
- E. Conduits entering the Telecommunications Room should be designed and located to allow for the most flexibility in the routing and racking of cables.
- F. Conduits or conduit sleeves entering through the floor of the Telecommunications Room shall terminate four (4) inches above the finished floor.
- G. All metallic telecommunications conduits entering the Telecommunications Room, Equipment Room, or Entrance Facility shall be bonded together and bonded to the Telecommunications Main Grounding Busbar with a #6 AWG ground cable.
- H. All in-use and spare conduits entering the Telecommunications Room, Equipment Room, or Entrance Facility shall be sealed to prevent the intrusion of water, gasses, and rodents throughout the construction project. Within five days of releasing the conduit for the installation of cable, the conduit installation contractor shall prove all conduits to be clean and dry.
- I. All conduits and cables penetrating fire-rated walls or floors must be fire-stopped.
- J. All OSP conduits and innerduct, used and spare, shall be plugged with watertight plugs at both ends to prevent water intrusion, gasses, and rodents throughout the construction project. All OSP conduits shall have pull lines rated at a minimum of 90 kg (200 lb) pulling tension installed. The pull lines must be re-pulled each time an additional cable is installed. Prior to releasing the conduit for the installation of cables, all OSP conduits must be cleaned with a brush pulled through the conduit at least two times in the same direction and swabbed with clean rags until the rag comes out of the conduit clean and dry. All OSP conduits must be tested with a mandrel to prove compliance with the sweep radius requirements throughout the conduit run. Within five

days of releasing the conduit for the installation of cable, the conduit installation contractor shall prove all conduits to be clean and dry.

- K. The Electrical Engineer and Architect of record shall make the final design and specifications for the Communications Systems conduits.
- L. Conduits shall be reamed to eliminate sharp edges. The metallic conduit shall be terminated with an insulated bushing. Refer to ANSI/TIA/EIA-606 and Section 270553 for the administration of the pathway system.
- M. The inside of the cable tray or wireway shall be free of burrs, sharp edges, or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) shall have the portion within the tray protected with a smooth, non-scratching covering so that the cable can be pulled without physical damage. When a wireway passes through a partition or wall, it shall be an unbroken length. Installation of telecommunications cables shall not exceed the fill requirements. Openings in fire-rated walls, floors, and ceilings shall be properly fire-stopped. Barriers between power and telecommunications cables shall be installed per electrical code. Cable trays and wireways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.
- N. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the applicable class as specified in the electrical code. A support should be placed within 600 mm (2 ft) on each side of any connection to a fitting. Wireways shall be supported on 1500 mm (5 ft) centers unless designed for greater lengths.
- O. A minimum of 300 mm (12 in) access headroom shall be provided and maintained above a cable tray. Care shall be taken to ensure that other building components, e.g., air conditioning ducts) do not restrict access to trays or wireways.

3.3 MINIMUM CLEARANCES

- A. Communication Pathway minimum clearances from:
 - 1. Minimum of 1 foot parallel, 3 inches crossover from power cables and conduits.
 - 2. Minimum of 6 inches above ceiling tiles.
 - 3. Minimum of 24 inches of Hot Steam pipes, Hot water pipes, and other hot surfaces.
 - 4. Minimum of 3 feet separation from electrical panel boards.
 - 5. Minimum of 12 inches from fluorescent fixtures.
 - 6. Minimum of 6 feet separation from electrical motors and transformers.
 - 7. Minimum of 2 inches from exposed all-thread rods.

3.4 FIRE STOPPING

- A. Provide fire-resistant materials to restore fire ratings to all wall, floor, or ceiling penetrations used in distributing and installing communications cabling systems. Coordinate fire-stopping procedures and materials with the General Contractor and Electrical Contractor.
- B. Solutions and shop drawings/submittals for fire stop materials and systems shall be presented to the General Contractor for written approval of materials before purchase and installation.
- C. Materials shall be installed per manufacturer instructions, be UL-listed for intended use, and meet NEC codes for fire-stopping measures.
- D. The material chosen shall be distinctively colored to be distinguishable from other materials, adhere to itself, and remain resilient and pliable to allow for the removal and/or addition of communication cables without drilling holes in the material.

- E. The fire-stopping material shall maintain/establish the fire-rated integrity of the wall/barrier that has been penetrated.
- F. Cable Contractor shall laminate and permanently affix to the MDF wall adjacent to chases the following information:
 - 1. Name of the manufacturer of the fire stop system.
 - 2. Part & model numbers of the system and all components.
 - 3. Provide the phone numbers of the manufacturer's corporate headquarters in the U.S. and the local distributor's name and phone number.

END OF SECTION 270528

**SECTION 27 0553
IDENTIFICATION OF COMMUNICATIONS SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified and in performing the following operations recognized as necessary for labeling the telecommunications infrastructure as described on the Drawings and/or required by these specifications.
- B. Labeling format is to be submitted to and approved by the Owner prior to implementation.

1.2 RELATED SECTIONS

- A. 270500 Common Work Results
- B. 270526 Grounding and Bonding
- C. 270528 Pathways for Communications Systems
- D. 270553 Identification for Communications Systems
- E. 271100 Communications Equipment Room Fittings
- F. 271500 Communications Horizontal Cabling
- G. 271600 Patch Cords, Station Cords, & Cross-Connect Wire
- H. 272000 Data Communications Equipment
- I. 273000 Voice Communications Equipment
- J. 274000 Audio Visual System

1.3 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA - 606-B Administration Standards.
 - 2. ANSI/TIA - 569-C Pathway and Spaces
 - 3. ANSI/TIA - 568-C Telecommunications Cabling Standard.
 - 4. BICSI Telecommunications Distribution Methods Manual.
 - 5. UL 969.

1.4 TELECOMMUNICATIONS ADMINISTRATION

- A. Administration of the telecommunications infrastructure includes documentation of cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, Telecommunications Rooms, and other telecommunications spaces.
- B. UNT maintains a campus-wide numbering scheme for voice and data outlets and patch panels.
- C. Telecommunications Infrastructure Records must be maintained in a computer spreadsheet or in a computer database. Paper records are encouraged but are optional. A cable record is prepared for each backbone cable. The document will show the cable name and must describe the origin point and destination point of the cable. The cable record will record what services and/or connections are assigned to each cable pair or strand. An equipment record is prepared for services distributed from a particular piece of equipment, such as a router or a system, such as a telephone system PBX.
- D. UNT requires the installer to keep accurate, up-to-date Installation or Construction Drawings. At a minimum, the Installation Drawings shall show pathway locations and routing, the

- configuration of telecommunications spaces, including backboard and equipment rack configurations, and wiring details, including identifier assignments.
- E. UNT requires the installer to provide a complete and accurate set of as-built drawings. The as-built drawings shall record the identifiers for significant infrastructure components, including the pathways, spaces, and wiring portions of the infrastructure, which may each have separate drawings if warranted by the complexity of the installation or the scale of the drawings.
 - F. As-built drawings must include MAC address for each Wireless Access Point referencing its physical location and port number.

PART 2 PRODUCTS

2.1 LABELS

- A. It shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
- B. It shall be preprinted or computer-printed type. Handwritten labels are not acceptable.
- C. Where insert-type labels are used, provide a clear plastic cover over the label.
- D. Outside plant labels shall be totally waterproof even when submerged.
- E. Approved Manufacturer:
 - 1. Panduit
 - 2. Brady Corporation
 - 3. Equivalent
- F. Equipment Room Copper, Fiber, and Coax Backbone Cable Labels
 - 1. Panduit Part#LS7-75NL-1 or Brady#WML-1231-292
- G. Equipment Room Copper, Fiber, and Coax Horizontal Cable Labels
 - 2. Panduit Part#LS7-75NL-1 or Brady#WML-317-292
- H. Work Area Copper, Fiber, and Coax Riser Cable Labels
 - 1. Panduit Part#LS7-75NL-1 or Brady #WML-317-292
- I. Patch Panel Labels
 - 1. Panduit Part #LS7-38-1 or Brady #CL-111-619

PART 3 - EXECUTION

3.1 IDENTIFICATION & LABELING

- A. All labels' size, color, and contrast should be selected to ensure the identifiers are easily read. Labels should be visible during the installation of and routine maintenance of the infrastructure.
 - 1. Workstations
 - a. Jack labels must be consistent between end point and MDF/IDF IT rooms.
Example: 1A-01= MDF 1A IT room 1st port in Station Rack. 2B-02= 2nd IT room IDF on 2nd floor 2nd port in Station Rack-3C 110- 3rd IT room IDF on 3rd floor 110 port in Station Rack.
 - b. Each communication outlet and ports of this outlet will be labeled as shown: if there is 1 IT room on the 1st floor of a building this IT room will be 1A. This will be the MDF. If there is another IT room on the 1st floor it will be 1B-etc. This is same on all floors of a building the 1,2,3,4,5 floors will change and if Multiple IT rooms are on a floor A, B, C D. At each communication outlet each port or jack will have the port number it is terminated in the IT room in the patch panel.
Example 1 cable from 1st IT room on 1st floor-1A-01, 2 cables from 2nd IT room on 2nd floor-2B-01-02, 3 cables from 3rd IT room on 3rd floor-3C-01-02-03.
 - 2. Wireless Access Points (WAP)

- a. Label each cable at both ends as specified.
 - b. Label must be placed on all WAP.
 - c. Label must state IT room number.
 - d. Label on patch panel – must have room number scheme per Wifi team.
- B. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light) and should have a design life equal to or greater than that of the labeled component.
- C. All labels shall be printed or generated by a mechanical device.

3.2 TELECOMMUNICATION IDENTIFIERS

- A. All voice and data outlets and patch panels shall be clearly marked using permanent means. Voice and data outlets shall use the following system of numbering and labeling. Each cable shall be labeled with the MDF or IDF room number and patch panel port number, as well as the following:
- B. OUTLET
 - C. DATA: Actual IDF/TR Room Number and Patch Panel Port Number.
 - D. VOICE: Actual IDF/TR Room Number and 110 block position.
 - E. MDF/IDF
 - F. DATA: Room Number & Jack Number on Patch Panel.
 - G. VOICE: Room Number and Jack ID.
 - H. When more than one TR is needed per floor, the room number of the TR shall be added to the numbering scheme.
 - I. When more than one data patch panel is needed per TR, the numbering scheme shall continue consecutively. Example: If two 48-port patch panels are required, the second patch panel will be labeled starting with port 49.
 - J. All voice, data outlet, and port numbers must match actual room numbers. Careful consideration should be given when developing and maintaining a numbering scheme so that the scheme matches the actual room numbers exactly, not the builder's room number.
 - K. All voice and data terminations in the TRs shall be made in numerical order by room number of each jack.
 - L. Outlet numbers shall be marked by permanent means on each cable at the outlet and at the TR.

END OF SECTION 270553

**SECTION 27 1100
COMMUNICATION EQUIPMENT ROOM FITTINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Uniform General Conditions, Supplementary General Conditions, and Division 1 - General Requirements apply to this Section.
- B. Section includes:
 - 1. Equipment Racks, Cabinets or Shelves
 - 2. Cable Management - vertical and horizontal
 - 3. Category 6/6A UTP Modular Patch Panels

1.2 RELATED SECTIONS

- A. 270500 Common Work Results
- B. 270526 Grounding and Bonding
- C. 270528 Pathways for Communications Systems
- D. 270553 Identification for Communications Systems
- E. 271100 Communications Equipment Room Fittings
- F. 271500 Communications Horizontal Cabling
- G. 271600 Patch Cords, Station Cords, & Cross-Connect Wire
- H. 272000 Data Communications Equipment
- I. 273000 Voice Communications Equipment

1.3 SUMMARY

- A. This Section specifies the Communications Equipment Room Fittings requirements and required components.
- B. Communications Equipment Room Fittings
 - 1. The existing IT Room on Level 2 will feed the newly renovated Level 1 Dining and Lobby areas.
 - 2. Space for new horizontal copper cabling and terminating hardware mounted in existing 19" racks will be provided in the IT room.
 - 3. The existing IT room will require the following:
 - a. Adequate space for any additional copper patch panels needed.
 - b. Cable support at the existing ladder tray system.
 - c. Horizontal cable management for new copper cabling.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS:

- A. Panduit

2.2 HORIZONTAL WIRE MANGEMENT:

- A. Panduit - NCMHF2 (Front Only)

2.3 COPPER PATCH PANELS:

- A. Panduit Mini-Com 24 port Category 6/6A Flat Patch Panels _ CPPL24WBLY
- B. Panduit Mini-Com 48 port Category 6/ 6A Flat Patch Panels _ CPPL48WBLY

PART 3 EXECUTION

3.1 SUBMITTALS

- A. Provide submittals according to the requirements of Division 01 and other requirements of this specification.
- B. Provide shop drawings for all telecommunications rooms showing the dimensions of all equipment to be installed as field conditions permit, including existing equipment. Telecommunications CAD drawings will be provided. However, shop drawings shall not be "regurgitated" but shall show accurate field conditions. Do not proceed with the installation of equipment in the telecommunications rooms until the shop drawing(s) are approved.
- C. Provide product submittals for:
 - 1. Category 6 and 6A Patch Panels
 - 2. Horizontal Wire Managers

3.2 EQUIPMENT RACKS, CABINETS, SHELVES

- A. Coordinate all work for final mounting locations of all equipment in existing racks.

3.3 CABLE MANAGEMENT

- A. Provide additional cable management to support newly installed Category cable to existing IDF plus 30% growth.

3.4 UTP PATCH PANELS

- A. Provide and install Category 6/6A patch panels in existing IDF.
- B. Quantities shall be adequate to terminate all Category 6/6A UTP cables associated with each IDF plus 30% growth.

3.5 CABLE TIES

- A. Use only Velcro-type cable ties to manage and secure cables within the IDFs.
 - 1. Form neat and orderly bundles of cabling in all cases where the cable is exposed to view.
 - 2. Individual cables shall not cross over or under ("divers") other cables along the length of an exposed bundle.

END OF SECTION 271100

**SECTION 271500
COMMUNICATIONS HORIZONTAL CABLING**

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.
- B. Specification Section 270500, Common Work Results for Communications, applies to this section.

1.2 SUMMARY

- A. This section specifies the requirements for the Communications Horizontal Cabling for the UNT Chilton Hall Renovation in Denton, Texas.
- B. All voice and data horizontal cables shall consist of plenum-rated, Category 6, 4-pair UTP copper terminated in the ER and TRs. The voice/data cables shall terminate at 48 port RJ-45 T568A. The maximum horizontal distance shall be 295 feet.
- C. All information outlets will be flush-type mounted into conduits and boxes. Typical outlets will be used in the office spaces and lab spaces. These outlets shall consist of 3 data cables unless otherwise specified. Each port in the data patch panel shall have eight conductors configured to RJ45 (ISDN) standard pin-out T568A.
- D. Outlet configurations. Single-gang mounting plate with modular openings, which might contain one or more of the following devices
 - 1. Data Jack(s) - 8-pin modular, Category 6, un-keyed, ivory, pinned to T568A standards (fully terminated).
 - 2. Blank Inserts – to be inserted in unused openings.
- E. Contractor must keep updated redline drawings and provide as-built documentation in both print and electronic formats.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Panduit

2.2 UTP COPPER CABLE

- A. Panduit Category 6 Plenum Rated CMP – Blue _ PUP6004BU-WLP
- B. Panduit Category 6A Plenum Rated CMP – Blue _ PUP6AM04

2.3 PATCH PANELS

- A. Panduit Mini-Com 24 port Category 6/6A Flat Patch Panels _ CPPL24WBLY
- B. Panduit Mini-Com 48 port Category 6/6A Flat Patch Panels _ CPPL48WBLY

2.4 COPPER CONNECTORS

- A. Panduit Category 6 Mini-Com TX-6 Module (Green) – Data _ CJ688TGGR
- B. Panduit Category 6 Mini-Com TX-6 Module (Orange) – Security Cameras _ CJ688TGOR
- C. Panduit Category 6A Mini-Com TX-6 Module (Yellow) – Access Points - CJ6X88TGYL

2.5 WALL PLATES

- A. Panduit Mini-Com Faceplate Sloped – 4 ports _ CFPSL4WHY
- B. Panduit Mini-Com Blank Module _ CMBWH-X
- C. Panduit 2 Module Surface Box _ CBXQ2IW-A

PART 3 EXECUTION

3.1 GENERAL

- A. Follow the manufacturer's installation guidelines.
- B. All data and voice cabling and terminations and termination hardware shall be ANSI/TIA wiring configuration T568A.
- C. The length of each run of horizontal cable from the administration subsystem (Telecommunications Room) to the Telecommunication Outlet shall not exceed 295 ft.
- D. The four-pair UTP cable shall be Underwriter's Laboratories (UL) listed type CMP.
- E. Pay strict attention to the manufacturer's guidelines on bend radii and maximum pulling tension during installation. Notice that the recommended minimum bend radius for a cable during installation is typically greater than the recommended bend radius after the cable is installed. This is to minimize tension and deformation as the cables pass around corners during installation. The maximum pull-force guideline for 4-pair horizontal balanced twisted pair cables is 110 N (25 lb).
- F. UTP Cabling:
 - 1. Provide a minimum of a 3-foot service loop (for re-termination) for horizontal cables. Locate the service loop where the horizontal cable run transitions to the cable tray. Place at least 12" of service loop in the outlet box.
 - 2. The horizontal distance is the cable length from the mechanical termination of the media at the horizontal cross-connect in the telecommunications room to the telecommunications outlet/connector in the work area. The maximum horizontal distance shall be 295 ft, independent of media type. The length of the cross-connect jumpers and patch cords in the cross-connect facilities, including horizontal cross-connects, jumpers, and patch cords that connect horizontal cabling with equipment or backbone cabling, should not exceed 5 m (16 ft) in length. For each horizontal channel, the total length allowed for cords in the work area plus patch cords or jumpers plus equipment cables or cords in the telecommunications room shall not exceed 10 m (33 ft).
 - 3. Cable and components shall be visually inspected for proper installation. Cable stress, such as that caused by tension in suspended cable runs and tightly cinched bundles, shall be minimized. Plenum-rated Velcro ties used to bundle cables should be applied loosely to allow the Velcro tie to slide around the cable bundle. The Velcro ties should not be cinched so tightly as to deform the cable sheath. Cable placement should not deform the cable sheath.
 - 4. Minimum bend radius: The minimum bend radius for the cable will vary depending on the condition of the cable during installation (tensile load) and after installation when the cable is at rest (no load).
 - 5. The minimum bend radius, under no-load conditions, for a 4-pair unshielded twisted-pair (UTP) cable shall be four times the cable diameter.
 - 6. Copper cable splicing or bridge tapping is unacceptable.
 - 7. Cables should be terminated with connecting hardware of the same category or higher. To maintain the cable geometry, remove the cable sheath only as much as necessary to terminate the cable pairs on the connecting hardware. The connecting hardware manufacturer's instructions for cable sheath strip-back shall be followed. When terminating Category 6 and higher cables, the cable pair twists shall be maintained to within 13 mm (0.5 in) from the point of termination. For best performance when terminating cable on connecting hardware, the cable pair twists should be maintained as close as possible to the point of termination.
 - 8. The Cable Contractor shall install 4-pair Category 6A plenum-rated UTP cables from the appropriate ER or TR to each outlet location as indicated on the telecommunications drawings.

3.2 SITE QUALITY CONTROL

- A. Site Testing and Inspection Agency qualifications:
1. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in ANSI/TIA-568-C.2-1 "Transmission Performance Specifications for 4-pair Category 6A Cabling". This document will be referred to as the "TIA Cat 6A Standard."
 2. The installed twisted-pair horizontal links shall be tested from the patch panel in the telecommunications room to the telecommunication wall outlet in the work area against the "Permanent Link" performance limits specification as defined in the TIA CAT 6A Standard.
 3. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals).
 4. The test equipment shall comply with the accuracy requirements for level III field testers as defined in the TIA CAT 6A Document. The tester, including the appropriate interface adapter, must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table C.2 of Annex B of the TIA CAT 6A Standard. (Table B.3 in this TIA document specifies the accuracy requirements for the Channel configuration.)
 5. The test plug shall fall within the values specified in E.3.2.2 Modular test plug NEXT loss requirements of the TIA CAT 6A Standard.
 6. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
 7. The tester interface adapters must be of high quality, and the cable shall not show any twisting or kinking resulting from coiling and storing the tester interface adapters. To deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The Cable Contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
 8. One hundred percent of the installed cabling links must be tested and must pass the requirements of the standards in this section. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing results of the tests for all links shall be provided in the test results documentation in accordance with the Test Result Documentation as listed below.
- B. Site Testing, Inspection, and Acceptance
1. The Pass or Fail condition for the link-under test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. To achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
 2. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.
 3. A representative of the design team shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.
 4. At the conclusion of field testing, at a time scheduled by the owner's representative,

the owner's representative will select a random sample (up to 10%) of the installed links in each wiring closet. Under the supervision of the owner's representative, the Cable Contractor shall test these randomly selected links, and the results are to be stored per the prescriptions in the Test Result Documentation as listed below.

5. The results obtained shall be compared to the data originally provided by the Cable Contractor. If any (one or more) of the sample test reports displays a fail or fail* result, the Cable Contractor shall resolve any conditions causing the failed test and, under the supervision of the owner's representative, shall repeat 100% of the testing and the Cable Contractor shall bear the cost.
- C. Performance Test Parameters
1. The test parameters for CAT 6A are defined in the TIA CAT 6A standard, which refers to the ANSI/TIA-568-C.2 standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 250 MHz) must meet or exceed the limit value determined in the standard mentioned above.
 - a. Wire Map
 - b. Length
 - c. Insertion Loss (Attenuation)
 - d. NEXT Loss
 - e. PSNEXT Loss
 - f. ELFEXT Loss, pair-to-pair
 - g. PSELFEXT Loss
 - h. Return Loss
 - i. ACR (Attenuation to crosstalk ratio)
 - j. PSACR
 - k. Propagation Delay
 - l. Delay Skew [as defined in ANSI/TIA-568-C.1; Section 11.2.4.11]
- D. Test Result Documentation
1. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test.
 2. The test results records saved by the tester shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., "as saved in the tester," at the end of each test and that these results cannot be modified at a later time. Superior protection in this regard is offered by testers that transfer the numeric measurement data from the tester to the PC in a non-printable format.
 3. The database for the completed job shall be stored and delivered on CD-ROM, including the software tools required to view, inspect, and print any selection of test reports.
 4. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
 - a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - b. The overall Pass/Fail evaluation of the link-under-test, including the NEXT Headroom (overall worst case) number.
 - c. The date and time the test results were saved in the memory of the tester.
 5. General Information to be provided in the electronic database with the test results information for each link:
 - a. The identification of the customer site as specified by the end-user.
 - b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - c. The overall Pass/Fail evaluation of the link-under-test.

- d. The name of the standard selected to execute the stored test results.
 - e. The cable type and the value of NVP used for length calculations.
 - f. The date and time the test results were saved in the memory of the tester.
 - g. The brand name, model, and serial number of the tester.
 - h. The identification of the tester interface.
 - i. The revision of the tester software and the revision of the test standards database in the tester.
 - j. The test results information must contain information on each of the required test parameters.
6. The detailed test results data to be provided in the electronic database for each tested link must contain the following information:
- a. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. In this case, the PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
 - 1) Length: Identify the wire pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1ft), and the test limit value.
 - 2) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns), and the test limit value.
 - 3) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns), and the test limit value.
 - 4) Attenuation: Minimum test results for the worst pair.
 - 5) Return Loss: Minimum test results for the worst pair as measured from each end of the link.
 - 6) NEXT, ELFEXT, ACR: Minimum test results documentation as explained in Section IB for the worst pair combination as measured from each end of the link.
 - 7) PSNEXT, PSELFEXT, and PSACR: Minimum test results documentation for the worst pair as measured from each end of the link.
- E. As-built drawings
- 1. Provide three (3) copies of E and three (3) copies of C-size prints along with CADD files in .dwg or .dgn formats showing floor plans with room numbers and actual outlet locations and labeling. The deliverable is required within five business days of final cable testing.
 - 2. Red Line Drawings: The contract must keep one (1) E-size set of floor plans on-site during work hours with installation progress marked and outlet labels noted. The contractor may be asked to produce these drawings for examination during construction meetings or field inspections.

END OF SECTION 271500

**JANUARY 16, 2025
ISSUE FOR CONSTRUCTION**

**SECTION 27 1600
COMMUNICATIONS CONNECTING CORDS, DEVICES & ADAPTERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Uniform General Conditions, Supplementary General Conditions, and Division 1 - General Requirements apply to this Section.
- B. Section includes Materials minimum requirements, workmanship, warranty, coordination drawings, storage and protection of materials, and submittals.
- C. Special Note: UNT is a Panduit-specific location and has requested that the Panduit 25-year Warranty be extended to this installation. This requires:
 - 1. The installer of the telecommunications infrastructure is to be a certified Panduit Gold.
 - 2. Panduit manufactures Category 6A Patch Cables.
 - 3. The project shall be registered for warranty, and test data shall be submitted for acceptance by Panduit.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specification Section 270500, Common Work Results for Communications, applies to this Section.

1.3 REFERENCES

- A. Codes and Standards (Latest issue and addenda)
 - 1. ADA Standards for Accessible Design 28 CFR Part 36
 - 2. U.S. Department of Labor Occupational Safety & Health Administration (OSHA)
 - 3. UNTHSC Telecommunications and Infrastructure Requirements
 - 4. BICSI TDM 11th Edition
 - 5. National Electric Code (NEC), Latest Issue
 - 6. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard*
 - 7. ANSI/TIA-568-C.2 - Commercial Building Telecommunications Cabling Standard*
 - 8. ANSI/TIA-568-C.3 - Optical Fiber Cabling Components Standard*
 - 9. ANSI/TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces*
 - 10. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructures, June 21, 2002*
 - 11. ANSI J-STD-607-A, Commercial Building. Grounding/Bonding Requirements- Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002*
 - 12. ANSI/TIA758-B - Customer-owned Outside Plant Telecommunications Infrastructure Standard, May 2005*
 - 13. International Standards Organization/International Electrotechnical Commission (ISO/IEC) IS 11801, 2000*
 - 14. Underwriters Laboratories (UL) Cable Certification and Follow-Up Program*
 - 15. National Electrical Manufacturers Association (NEMA)*
 - 16. American Society for Testing Materials (ASTM)*

1.4 SUBMITTALS

- A. See Section 01-30-00 - Administrative Requirements for submittal procedures.

1.5 WARRANTY

- A. See Section 01-78-00 - Closeout Submittals for additional warranty requirements.
- B. All materials, items of equipment, and workmanship furnished under each Section shall carry a ONE (1) YEAR warranty against all defects in material and workmanship. Any fault under any Contract due to defective or improper material, equipment, workmanship, or design which may develop shall be made good, instantly, by and at the expense of the Contractor for the work under his Contract, including all other damage done to areas, materials, and other systems resulting from this failure.
- C. The Contractor shall guarantee that all elements of the system, which are to be provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.
- D. Upon receipt of notice from the Owner of the failure of any part of any systems or equipment during the guarantee period, the Contractor shall replace the affected part or parts for his respective work, as applicable.
- E. An additional extended warranty is required for work on this project. The additions and/or extensions to the standard year guarantee previously described are to be provided in writing by the Manufacturers. The warranty is to cover all parts and labor as specified below:
- F. Panduit Gold 25-year performance certification for:
 - 1. Category 6 and 6A, cable, and associated labor.
 - 2. Category 6 and 6A, patch panels, and associated labor.
 - 3. Category 6 and 6A, data workstation outlets, and associated labor.
- G. Furnish, before the final payment is made, a written guarantee covering the above requirements.
- H. Additional/extended warranty listed above is Non-negotiable and cannot be amended through the submittal process.

PART 2 PRODUCTS

2.1 Approved Manufacturers:

- A. Panduit

2.2 COPPER PATCH CABLES

- A. Category 6A copper patch cables shall be provided, one for each "wired for" data circuit as listed in Section 27 15 00 or as required otherwise by this Contract.
- B. One copper patch cable terminated with RJ-45 connectors shall be provided, one for each "wired for" voice circuit as listed in Section 27 15 00 or as required otherwise by this Contract.
- C. Copper patch cables shall be of the same Category and manufacturer as the cable listed in Section 27 15 00 as necessary to meet the extended manufacturer's warranty requirements listed in Section 27 05 00.
- D. Copper patch cables shall be of variable lengths to form neat and workmanlike groups within the cable management.
- E. Category 6 and 6A Patch Cords
 - 1. Panduit CAT 6 (Green) 5ft. - UTP28SP5GR
 - 2. Panduit CAT 6A (Yellow) 5ft. - UTP6ASD5YL Y
 - 3. Panduit CAT 6 (Green) 14ft. - UTP28X14GR
 - 4. Panduit CAT 6A (Yellow) 14ft. - UTP6ASD14YL Y

- 5. Panduit CAT 6 (Orange) 5ft. - UTP28SP5OR
- F. 2 Port Module Surface Box
 - 1. Panduit Mini-Com® Surface Mount Box - CBXQ2IW-A

PART 3 EXECUTION

3.1 COPPER PATCH CABLES

- A. Provide two (2) patch cables for each "wired for" voice/data circuit.
- C. Lengths shall be 50% 1' and 50% 15'.

END OF SECTION 271600

**SECTION 27 2000
DATA COMMUNICATIONS EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The requirements for the Data Communications Equipment at the Chilton Hall for The University of North Texas in Denton, Texas.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specification Section 270500, Common Work Results for Communications, applies to this Section.

1.3 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA- 606-B Administration Standards.
 - 2. ANSI/TIA-569-B Pathway and Spaces
 - 3. ANSI/TIA-568-C Telecommunications Cabling Standard.
 - 4. BICSI Telecommunications Distribution Methods Manual.
 - 5. UL 969.

1.4 SUMMARY

- A. Data Communications Equipment
 - 1. Data Communications Equipment includes customer-owned routers, servers, Ethernet switches, personal computers, printers, wireless access points, etc., required to connect the Dining Hall to the rest of the campus, the internet, and the public switched telephone network (PSTN).
 - 2. Owner provides Data Communications Equipment at UNT.
 - 3. Data Communications Equipment will be owner-furnished and owner-installed (OFOI).
 - 4. The Cable Contractor shall fully cooperate and coordinate with the Owner as required to ensure proper integration and connectivity between systems.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 COORDINATION

- A. Cable Contractor shall fully coordinate with the Owner's Data Communications Equipment providers as required to ensure proper integration and connectivity between systems.
- B. Cable Contractor shall furnish a labeled floor plan and Excel run sheet to the Owner's Data Communications Equipment provider two weeks prior to occupancy.
- C. Cable Contractor shall furnish and install all patch cords in conjunction with the Owner's Data Communications Equipment provider.

- D. The cable contractor shall provide adequate technician support when the Owner's data communications equipment providers are planning and installing new data equipment and connectivity.
- E. Cable Contractor shall provide adequate technician support on the first business day after Data equipment installation and connectivity.

END OF SECTION 272000

**SECTION 27 3000
VOICE COMMUNICATIONS EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The requirements for Voice Communications Equipment for UNT Chilton Hall in Denton, Texas.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Specification Section 270500, Common Work Results for Communications, applies to this Section.

1.3 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA- 606-B Administration Standards.
 - 2. ANSI/TIA-569-B Pathway and Spaces
 - 3. ANSI/TIA-568-C Telecommunications Cabling Standard.
 - 4. BICSI Telecommunications Distribution Methods Manual.
 - 5. UL 969.

1.4 SUMMARY

- A. Voice Communications Equipment
 - 1. Voice Communications Equipment includes customer-owned phones, faxes, etc., required to connect the Dining Hall to the rest of the campus and the public switched telephone network (PSTN).
 - 2. The owner provides Voice Communications Equipment at UNT.
 - 3. Voice Communications Equipment will be owner-furnished and owner-installed (OFOI).

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 COORDINATION

- A. Cable Contractor shall fully coordinate with the Owner's Voice Communications Equipment provider as required to ensure proper integration and connectivity between systems.
- B. Cable Contractor shall furnish a labeled floor plan and Excel run sheet to the Owner's Voice Communications Equipment provider two weeks prior to occupancy.
- C. Cable Contractor shall furnish and install all patch cords in conjunction with the Owner's Voice Communications Equipment provider.
- D. The cable contractor shall provide adequate technician support when the owner's voice communications equipment provider plans and installs new voice and data equipment and connectivity.
- E. Cable Contractor shall provide adequate technical support on the first business day after the installation and connectivity of voice equipment.

END OF SECTION 273000

**SECTION 27 4000
AUDIOVISUAL SYSTEMS**

PART 1 GENERAL

1.1 DEFINITIONS

- A. Owner: University of North Texas (UNT)
- B. Project: Chilton Hall Level 1 Renovation
- C. Architect: Treanor
- D. Consultant: 4b Technology Group
- E. Contractor: Contractor or subcontractor providing and installing the audiovisual system
- F. GC: General Contractor
- G. OFE: Owner Furnished Equipment
- H. OFOI: Owner Furnished Owner Installed
- I. OFCI: Owner Furnished Contractor Installed
- J. CFCl: Contractor Furnished Contractor Installed

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section includes furnishing, installing, testing, and documenting the audiovisual system for digital signage systems along with executive office, huddle room, team room and community/living room locations in the Owner's Project.
- B. General elements of the work will consist of (but are not limited to) the following:
 - 1. Procuring all permits and licenses required by local governing bodies for complete and functional audiovisual system installation.
 - 2. Attending pre-construction/pre-submittal meetings with Owner and Consultant to review design package for the audiovisual system.
 - 3. Providing continuous on-site supervision of installation technicians.
 - a. On-site supervision will include daily oversight of work, updating worksite progress drawings to reflect changes and installations details, preparing weekly progress reports, and attending on-site coordination meetings as directed by the Owner and Consultant
 - 4. Providing equipment, labor, materials, tools, appliances, and transportation required for a complete and functional audiovisual system as described within the design specifications and drawings.
 - 5. Providing all miscellaneous hardware including (but not limited to) cable management devices, termination cabinets, cable labeling materials, fasteners, hangers, and brackets required for complete and functional audiovisual system installation.
 - 6. Providing all required audiovisual system software and licenses to the Owner.
 - 7. Coordinating with all trades and Owner representatives as required to facilitate the installation of control systems equipment including (but not limited to) door hardware, fire alarms, blinds, shades, HVAC, and electrical divisions.
 - 8. Coordinating and documenting receipt of Owner furnished equipment.
 - 9. Protecting new facilities finishes and equipment.
 - 10. Maintaining construction materials and refuse within the area of work on-site.
 - 11. Cleaning the work area on-site at the end of each day and disposing of waste in designated refuse bins or containers.

12. Coordinating network settings, configurations, and requirements in conformance to owner standards (i.e. isolated AV network, AV VLAN, etc.) to ensure proper function of the audiovisual system equipment.
- C. The work described in these specifications and drawings have been provided to meet certain performance requirements.
 1. Some information such as exact equipment models, layout, wire routing, conduit pathway, power requirements, etc. has been omitted.
 2. The audiovisual system is designed to efficiently support the Owner's various facilities and activity areas in a manner which can be reasonably and proficiently managed by the staff.
 3. Contractor is responsible for translating these specifications and drawings into a complete design package containing all the necessary elements to deliver a complete turnkey installation including (but not limited to) all materials, labor, warranties, shipping and permits.
 - a. In the event of any conflicts between design specifications and drawings, the Contractor will provide written notification to Consultant of any such occurrences before purchasing any equipment or materials and performing any installation services.
 - i. The Consultant will notify the Contractor of any actions required to resolve these conflicts which may include (but not be limited to) design changes, equipment, materials and/or installation changes.
 - ii. In any event, Contractor will not supersede specifications and standards from the latest NFPA and NEC publications.
- D. In all cases, the Contractor is solely responsible for the performance of the audiovisual system and the delivery of complete system documentation for each part of the Project.

1.4 ROOM TYPE FUNCTIONAL NARRATIVES

- a. N/A

1.5 PROGRAMMING

- A. Coordinate and provide programming review meeting(s) with Owner to address and advise on control system capabilities (per room type) based on Project drawings and specifications.
- B. Deliver control system and digital signal processor programming source code configuration files (both compiled and uncompiled per room type) to the Owner as a requirement for final acceptance of the audiovisual system.
- C. Provide programming labor to cover audiovisual system functional control changes and modifications requested by the Owner within the warranty period beginning after the final acceptance date.
- D. Refer to 1.8 – SUBMITTALS later in this document for additional requirements.

1.6 BID RESPONSE

- A. Provide a bid response document with line-item pricing that is formatted and organized to identify unique room types, locations, and/or general systems along with the total installation cost associated for each.
- B. Line-item pricing per room type, location, or general system will include (but is not limited to) equipment, accessories, software, hardware, subscriptions, licenses, labor types, general, administrative, and miscellaneous costs required for installation of a functional audiovisual system.
 1. The provided equipment list should contain line-item manufacturer, model, quantity, unit cost and extended cost information for each component in that specific room type, location, or general system.
 2. Installation labor per room type, location, or general system should be presented separately from the associated equipment list with line-item pricing.
 3. General, administrative, and miscellaneous equipment or labor costs including (but not limited to) design, drawing production, programming, project management, shipping,

handling, and training per room type, location or general system should also be presented separately with line-item pricing for each category.

4. Please see the following example for Bid Response Pricing Data submittal package formatting guidance:

Sample Bid Response Pricing Data

Room Type	Manufacturer	Model	Qty.	Unit Cost	Ext. Cost
Huddle Room	Product	A	1	1.00	1.00
	Product	B	2	1.00	2.00
	Contractor	Install Labor	1 hr.	1.00	1.00
	Contractor	Programming	2 hr.	1.00	2.00
	Contractor	Project Management	3 hr.	1.00	3.00
	Contractor	Training	1 hr.	1.00	1.00
	Contractor	Shipping	N/A	1.00	1.00
	Contractor	Miscellaneous	N/A	1.00	1.00
					SUBTOTAL
Conference Room	Product	A	1	1.00	1.00
	Product	B	2	1.00	2.00
	Product	C	1	1.00	1.00
	Contractor	Install Labor	2 hr.	1.00	2.00
	Contractor	Programming	3 hr.	1.00	3.00
	Contractor	Project Management	4 hr.	1.00	4.00
	Contractor	Training	2 hr.	1.00	2.00
	Contractor	Shipping	N/A	2.00	2.00
	Contractor	Miscellaneous	N/A	2.00	2.00
				SUBTOTAL	19.00
				TOTAL	31.00

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Contractor will have a minimum of five years' experience installing, programming, and commissioning audiovisual systems of a comparable size and scope.
2. Contractor's project installation team will feature at least one individual with an active Certified Technology Specialist – Installer (CTS-I) designation to supervise and approve all on-site work.
3. Contractor's project installation team will feature a dedicated Project Manager whose responsibilities include (but are not limited to) the oversight of system programming, operations and maintenance manual preparation, training coordination, testing protocols, testing documentation, document deliverables, and labor scheduling.
4. Contractor's project installation team members must demonstrate knowledge and compliance with all AVIXA, TIA, UL, and NEC methods, standards, and codes.
5. Contractor's project installation team must be certified by industry groups and/or equipment manufacturers relevant to this project's scope of work and bill of materials as having completed the training necessary to perform their specific installation task(s).
6. Owner's representative(s) may make such investigations (as deemed necessary) to determine that the Contractor is responsive, responsible, and qualified to execute the work outlined by the Contract.
 - a. In this regard, the Contractor will furnish to the Owner such information as requested for this purpose.
 - b. Information and data may include (but not necessarily be limited to) the date of

organization and/or incorporation, number of years engaged in this business under present firm's name, a list of major equipment owned by the company, a list of principal personnel who will be involved in the execution of this contract along with the experience and qualifications of each person.

7. Contractor will be an authorized manufacturer's representative for all products which they install.
 8. Contractor will have in-house engineering and project management staff with capabilities to satisfy the requirements of the Project and located no more than one hundred miles away from the Owner's site.
 9. Contractor will have a consistent presence (or subcontractor organization) located no more than one hundred miles away from the Owner's site that can provide maintenance and services for the for the audiovisual system during the required (or optional extended) warranty period.
 10. Contractor will be capable of providing emergency maintenance and service twenty-four hours per day, seven days per week.
- B. The Contractor will provide all materials, equipment, and installation in compliance with the latest applicable standards from ANSI, ASTM, AVIXA, FCC, IEEE, NCTA, NEC, NEMA, NFPA, REA, TIA/EIA, and UL including (but not limited to):
1. American National Standards Institute (ANSI)
 2. ANSI T1.404 (DS3) and CATV Applications
 3. American Society for Testing and Materials (ASTM)
 4. American with Disabilities Act (ADA)
 5. EIA/TIA-569 Standard, Commercial Building Standard for Telecommunications Pathways and Spaces
 6. EIA/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
 7. National Cable Television Association (NCTA)
 8. NCTA-02 NCTA Recommended Practices for Measurements on Cable Television Systems
 9. National Electrical Code (NEC) (latest revision and pertinent addendums)
 10. Article 250, Grounding
 11. Article 300, Part A. Wiring Method
 12. Article 310, Conductors for General Wiring
 13. Article 800, Communication Systems
 14. National Fire Protection Association (NFPA) Publications (latest revisions and pertinent addendums)
 15. Underwriters Laboratories (UL)
 16. NECA 1 Good Workmanship in Electrical Contracting
- C. Electrical Components, Devices and Accessories:
1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.8 SUBMITTALS

- A. Contractor's CTS-I supervisor will review, approve, and sign off on all submittal documents.
- B. Provide evidence of compliance with specifications described in 1.7 - QUALITY ASSURANCE as requested by the Owner and/or Consultant.
- C. Partial submittals will not be acceptable without prior approval in writing from the Consultant.
- D. Until the Consultant approves the full submittals, the Contractor will not commence any work, nor will the Contractor order any equipment related to the audiovisual system.
- E. Approval of submittals does not relieve the Contractor from any contract-required responsibilities.
- F. Product Data
 1. Provide cut sheets for each component within in a unique room type, room location, and/or general system and include notes on the cut sheet identifying specific models, color

- finishes, accessories, or relevant selection details (when multiple options are shown in any category) for that equipment.
2. Organize cut sheets into a single .pdf package with an index on the first page which specifies the following information:
 - a. Room type, room location, and/or general system name
 - b. Equipment manufacturer and model name of each component within that room type, room location, and/or general system
 - c. Color option availability of each equipment component
 - d. Color selection specification of each component per room type, room location and/or general system name (where applicable)
 - e. Page number location within the submittal package for the first cut sheet of each component.
 3. When custom equipment (podium, lectern, in-room rack, etc.) is specified for the Project that features multiple selection options (finishes, accessories, logos, etc.), the Contractor will provide a completed version of the manufacturer's configuration document and/or a copy of the manufacturer's unique quote featuring all customized selections within the Product Data submittal package.
 - a. Coordination meeting(s) between the Contractor and Architect may be required to review and advise on custom equipment configuration options based on Project drawings and specifications.
 4. The following example shows the minimum information required for review of Contractor's Product Data submittal package:

Sample Index

Room Type	Color Option	Color Selection	Page #
Huddle Room			
- Product A	✓	White	2
- Product B	x	N/A	3
Conference Room			
- Product A	✓	Black	2
- Product B	x	N/A	3
- Product C	✓	Custom	4
Page			1

Sample Product Data

<p><u>Product A</u></p> <p>Cut Sheet</p>
Page 2

Sample Product Data

<p><u>Product B</u></p> <p>Cut Sheet</p>
Page 3

Sample Product Data

<p><u>Product C</u></p> <p>Custom Configuration Document or Manufacturer's Custom Quote</p>
Page 4

- G. Programming
 1. Provide screenshots, templates, and functional examples of all graphic user interface design which will be displayed on audiovisual system control equipment including (but not

limited to) touch panels, button panels, and web or desktop applications for sign off and approval by the Owner.

- a. Contractor must obtain written approval from Owner for all graphic user interface design and functionality (per room type) prior to deployment of audiovisual system programming.
 - b. Without written approval, Owner reserves the right to reject graphic user interface design and/or functionality and require specific updates to satisfy their programming requirements.
- H. Shop Drawings
1. Contractor's on-site supervisor will review, approve, and sign off on all shop drawings, coordination drawings and as-built drawings.
 2. The contract design documents (including but not limited to floor plans, reflected ceiling plans, wiring schematics, elevations, details, or section drawings) will not be accepted as submittals and do not relieve the Contractor from the obligation to produce and provide their own shop drawings.
 3. Shop drawings to include the following:
 - a. Drawing legend sheet identifying and describing all symbols used on the Contractor's documents
 - b. Floor plans and reflected ceiling plans showing all audiovisual system equipment with wiring pathways represented
 - c. Dimensioned elevations and sections showing wall, ceiling and/or surface mounted audiovisual system equipment
 - d. Details showing mounting and installation specifications for audiovisual system equipment.
 - e. Schematic block diagrams for each audiovisual room type featuring equipment manufacturer and model information with connector level details for all system components including (but not limited to) audio, video, control, and power signals
 - f. Elevations for all equipment racks including (but not limited to) ceiling enclosures, wall enclosures, lecterns, and teaching consoles
 - g. Cable runs with tags for type, gauge, quantities, and cable identifiers
 - h. System riser diagram indicating all field devices, riser paths and room designations as required.
 - i. Fabrication shop drawing(s) showing component layout and location of custom configured equipment (cable cubby, podium, lectern, etc.) for approval by the Owner.
- I. Samples
1. As requested, provide samples to the Owner and/or Architect for audiovisual system equipment color and texture finish coordination.
- J. Resubmitting
1. If any submittal documents are rejected by the Consultant, the Contractor will be responsible for making the required corrections or changes identified by the Consultant's stamp instructions and attached comments.
 - a. Contractor will clearly identify corrections or changes on resubmitted documentation by clouding areas which have been updated.
 - b. Consultant will only review clouded areas of correction or change within resubmitted documentation.
 2. Contractor will be responsible for project delays caused by rejected submittals.
 3. If both the Contractor's original submittals and resubmittals are each rejected, then the Consultant will be compensated for the additional services required to review the third (and any subsequent) Contractor submittal documents.
 - a. The amount of such compensation will be incorporated via change order and withheld from the Contractor application for payment.

1.9 ENVIRONMENTAL CONDITIONS

- A. Audiovisual system components will be rated for the environments where they are proposed to be installed.

- B. Manufacturer environmental (temperature, humidity, etc.) ratings and requirements will be followed exactly to ensure reliable equipment operation and maintain warranty coverage.
- C. Contractor will be responsible for verifying that the environmental conditions of the proposed audiovisual system equipment installation location does not exceed the minimum/maximum ratings and requirements of the specified audiovisual system components.
- D. The following are environmental control requirements for interior equipment spaces as described in the BICSI Telecommunications Distribution Methods Manual (TDMM), 13th Edition:
 - 1. Temperature: $\approx 18^{\circ}\text{C}$ to $\approx 27^{\circ}\text{C}$ ($\approx 64^{\circ}\text{C}$ to $\approx 81^{\circ}\text{F}$)
 - 2. Relative humidity: 60%
 - 3. Heat dissipation: ≈ 751 to ≈ 5016 BTU (220 to 1470 watt-hours) per cabinet

1.10 PROJECT COORDINATION PLAN

- A. Contractor will submit a project plan to the General Contractor detailing the steps and associated timeframe to meet the Project's schedule requirements. Project plan should include benchmarks for items such as regular project meetings, equipment ordering, delivery, installations, configuration, calibration, testing, burn-in, training, substantial completion notification, final testing, and final acceptance.
- B. Contractor assumes responsibility for coordinating with building trades or other parties that may be identified by the General Contractor to ensure functional delivery of the audiovisual system.
- C. Contractor will coordinate size and location of conduit systems, back boxes, and provisions for electrical power to specified audiovisual system equipment.
- D. Contractor will obtain written permission from the General Contractor prior to routing and/or installing cable, equipment, or service through the facility.
- E. Contractor will prepare the installation schedule to coordinate sequencing, dependencies, and priorities of the audiovisual system installation including work by other trades.

PART 2 PRODUCT

2.1 APPROVED MANUFACTURERS & ALTERNATES

- A. The following product specifications (along with those detailed on the project drawings) are presented as a basis of design in order to set minimum levels of acceptable equipment performance and functionality standard.
- B. Contractor may make equipment substitutions for alternate manufacturers and/or models so long as they meet or exceed the performance and functional standard set forth in the basis of design.
- C. Should Contractor make substitutions for alternate manufacturers and/or models, Contractor must provide to Consultant the following:
 - 1. A comprehensive list documenting the originally specified equipment and the make/model of equipment which is being proposed as an alternate.
 - 2. Notation on the Product Data submittal package identifying which equipment therein is an alternate and what originally specified equipment it is being substituted for.

2.2 CABLE

- A. Where applicable, Provide white cable for all audiovisual horizontal cabling.
 - 1. Refer to Telecom specification to avoid cable color conflict.
- B. 70 Volt Speaker Cable
 - 1. Minimum 16 AWG, twisted, stranded CL2/CL2P unless otherwise noted schematically.
- C. Low Impedance Speaker Cable
 - 1. Minimum 12 AWG, twisted, stranded CL2/CL2P unless otherwise noted schematically.
- D. Microphone Level Cable

1. Minimum 22 AWG, with 22 AWG drain wire, shielded, twisted, stranded CL2/CL2P unless otherwise noted schematically.
- E. Line Level Cable
 1. Minimum 22 AWG, with 22 AWG drain wire, shielded, twisted, stranded CL2/CL2P unless otherwise noted schematically.
- F. Low Voltage Control Cable
 1. Minimum 18 AWG twisted, stranded CL2/CL2P unless otherwise noted schematically.
- G. Category cable
 1. Cat6A UTP for isolated audiovisual networks.
 2. For cables connected to the Owner's network, refer to Telecom specifications.
- H. HDBaseT/Crestron DM/Extron XTP – Manufacturer's recommendation for maximum available resolution, frame rate, color sampling, color depth and distance of connected hardware.
- I. Minimum acceptable audiovisual system systems wiring performance standards will be as follows:
 1. Speaker cable - Per ANSI WC57 standard test.
 2. CAT6 - Per ANSI/TIA/EIA-568-8.1 standard test.
 3. Fiber optic cable - Per ANSI/TIA/EIA-568-B standard test.
 4. RS 232 - Per ANSI/ WC66 standard test.
 5. Line level shielded audio cable - Per ANSI WC66 standard test.
 6. Microphone level shielded audio cable - Per ANSI WC66 standard test.
 7. Video coaxial cable - Per ANSI/TIA/EIA–TSB-67standard test.
 8. Multi-conductor control cable - Per ANSI WC57 standard test.

2.3 AUDIOVISUAL PATHWAY

- A. Install j-hooks or saddlebags four to five feet apart. Avoid uniform spacing to minimize problems with signal degradation.
- B. Support j-hooks or saddlebags from decking or building structure using methods approved by the manufacturer.
- C. Cable count will not exceed manufacturer's recommended maximum. Add separate parallel j-hook pathway when cable count requires it.

2.4 AUDIOVISUAL PATCH CABLES

- A. Provide audiovisual patch cables for all audiovisual plates and interconnectivity locations.
- B. Minimum 6' patch cables for device interconnect cabling.
- C. Minimum 12' patch cables for user interface connection.
- D. Approved manufacturers:
 1. Extron
 2. Crestron
 3. Cables To Go (Premium)
 4. Or approved equal

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor will be responsible for providing all wire and cable as required for complete and functional audiovisual system operation.
- B. All cables must be continuous runs from the device location to the ultimate point of termination. Mid-run cable splices or couplers are not acceptable.
- C. Make cable connections with solderless devices that are mechanically and electrically secure in accordance with manufacturer's recommendations.
- D. Installation techniques which may degrade the mechanical and communications characteristics of audiovisual system cables are *not* acceptable.

- E. The Contractor will not place audiovisual system wiring in the same conduit or raceway with wire for electrical power distribution.
- F. Wiring Method
 - 1. Cable distribution will be accomplished using cable trays, j-hooks, cable runways, conduit raceways, ducts, core holes, extended columns, false half-columns, and plenums.
 - 2. Install cables in raceways in all locations as indicated in the design specifications and drawings excluding (but not limited to) accessible indoor ceiling spaces and hollow gypsum-board partitions.
 - 3. Conceal all raceways and associated wiring as indicated in the design specifications and drawings excluding (but not limited to) unfinished spaces
 - 4. Horizontal cable segments will be supported by distribution rings when cables enter and exit cable trays.
 - 5. Cables will be supported by cable runways and distribution rings when they converge at equipment room locations
 - 6. All cable placements will be based on design specifications and drawings.
- G. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bend radius.
 - a. Provide and use lacing bars and distribution spools where necessary to accomplish the above requirements.
- H. Splices, Taps and Terminations
 - 1. For power and control wiring, use numbered terminal strips in junction, pull boxes, outlet boxes, terminal cabinets, and equipment enclosures.
 - 2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
 - a. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- I. Grounding & Bonding
 - 1. The Division 26 contractor will be responsible for providing the required grounding means for all audiovisual system equipment per the NFPA 70, National Electrical Code (latest adopted edition), additional applicable codes, laws, or regulations from federal, state, and local AHJs, the direction from the licensed electrical engineer of record for the Project, and from the audiovisual manufacturer's recommendations.
 - 2. Contractor will be responsible for ensuring ground continuity by properly bonding all appropriate audiovisual cabling, closures, cabinets, service boxes and framework to the main building grounding electrode system.
 - a. All bonding connections will consist of minimum 12 AWG copper wire and will be bonded to the approved main electrical ground for the building.
 - b. Contractor will coordinate with electrical engineer of record for the Project to ensure the proper grounding and bonding is completed for the audiovisual system.

3.2 CONSTRUCTION MEETINGS

- A. The Consultant and/or Owner will hold regular construction meetings to review the installation schedule. It is mandatory that the Contractor's Project Manager attend each meeting.

3.3 SITE INSPECTION

- A. Continuously verify that the site conditions agree with the Contract Documents and the audiovisual system design. Notify Owner's representative immediately of conditions that effect the performance of the installed system.
- B. Identify and coordinate any required work that is not specified in the Contract Documents.
- C. Identify and coordinate any special environmental conditions for equipment installation that is not specified in the Contract Documents.

3.4 COORDINATION

- A. Verify adequate conduit, back boxes and power have been provided for the audiovisual system installation.
 - 1. Notify General Contractor immediately of discrepancies and/or deficiencies identified in any of these categories.

3.5 IDENTIFICATION, LABELING AND DOCUMENTATION

- A. Equipment Identifications
 - 1. The Contractor will label all termination devices, panels, enclosures, and equipment rooms.
 - 2. The Contractor will mark each unit with permanently attached markings that will not impair the equipment or present a hazard to maintenance personnel.
- B. Cable Labeling
 - 1. Place wire identification numbers ¼" on each end of all conductors and or connectors by using sleeve-type heat shrinkable markers.
 - 2. Install markers to be readable from left to right or top to bottom.
 - 3. Wire numbers will be computer printed (Brady TLS2200 with Permasleeve cable marking labels or equivalent). Hand-written labels are not acceptable.
 - 4. Mark all spare conductors.
- C. Project Documentation
 - 1. The Contractor will establish and maintain complete system documentation including (but not limited to) the following:
 - a. Floor plan and reflected ceiling drawings that indicate device locations, conduit locations, junction box locations and wire routing pathways
 - b. Mounting details for all equipment and hardware
 - c. Functional block diagrams for each room type with cable type identification
 - d. Rack elevations
 - 2. Contractor to maintain a progress set of design documents which will be updated daily to reflect the current condition of the work and made available for review by the Consultant and Owner upon request.
 - 3. If audiovisual system changes occur prior to acceptance testing which alters the previously furnished documentation, the Contractor will formally update and reissue the relevant documentation to the Consultant and Owner.
 - 4. Consultant and Owner may review all documentation for accuracy and completeness and may reject substandard submittals.

3.6 FIELD QUALITY CONTROL

- A. Inspection
 - 1. Verify that units and controls are installed, connected, and labeled in accordance with the design specifications and drawings.
 - 2. Verify that interconnecting wires and terminals are identified in accordance with the design specifications and drawings.
- B. Pre-testing
 - 1. Verify that audiovisual system components function in compliance with the design specifications and drawings with equipment, wiring and control functionality adjustments made, as necessary.
- C. Test Schedule
 - 1. Provide a minimum of ten days' notice of test schedule to Owner.
 - a. Contractor will schedule testing with the Owner after normal and functional audiovisual system operation has been observed for a period no less than fourteen days after pre-testing.
- D. Operational Tests
 - 1. Perform operational system tests for each room type to verify that audiovisual system complies with design specifications and drawings.

2. Include all modes of system operation during testing procedures.
 3. Evaluate each component for proper operation in all functional modes.
 4. Record test results for each room type and piece of equipment.
 5. Remove and replace malfunctioning items and retest as specified above.
- E. Re-test:
1. Correct deficiencies identified or observed during the testing process and re-test until specified requirements are met.

3.7 SPEAKER SYSTEM CONFIGURATION

- A. Equalize speaker systems flat from 80 Hz to 2 KHz.
- B. Program speaker systems with a high pass filter at 60Hz with 12dB per octave roll-off and a low pass filter 15 KHz with 12 dB per octave roll-off.
- C. The Contractor will provide calibration of speaker systems using sound analyzing software/hardware (SmaartLive, TEF SoundLab, Meyer's SIM or equivalent), a suitable calibration microphone, and a trained operator capable of making (or recommending) appropriate system adjustments including (but not limited to) delay timing, cabinet aim and equalization.
- D. Use a minimum of three measurement locations in the speaker systems intended coverage area to calibrate the system response.
- E. The Contractor will coordinate speaker testing and calibration with the expectation that this work will take a minimum of one hour per room type.
 1. The Contractor will be responsible for coordinating with the Owner to ensure that the working environment will be quiet room during speaker testing and calibration times.
- F. Contractor to record all speaker system measurements, settings, and adjustment for inclusion in the operations and maintenance manuals.

3.8 TRAINING

- A. Contractor will provide competent instruction personnel to train the Owner's general, operations, facilities, maintenance and/or technical support staff on topics including (but not limited to) location, operation and troubleshooting of the installed systems.
- B. Contractor to produce a custom, quick reference guide per room type with the most inexperienced audiovisual system user as the intended audience.
 1. Provide one laminated hard copy for each room location as part of the final documentation package.
 2. Provide one digital copy of the quick reference guide for each room type as part of the final documentation package.
- C. Contractor will develop separate training plans with "general users" (low audiovisual technology comprehension) and "power users" (high audiovisual technology comprehension) as the intended audience.
 1. "General user" training will minimally consist of:
 - a. Two independent sessions, each one-hour in duration per room type.
 - b. Printed reference material for each attending trainee (written in plain language) addressing normal day-to-day operations, selectable control system features, and basic system block diagrams.
 - c. Review of the quick reference guide per room type.
 - d. Demonstration of control system functionality per room type.
 - e. Question and answer session.
 2. "Power user" training will minimally consist of:
 - a. Two independent sessions, each one-hour in duration per room type.
 - b. Detailed explanation of audiovisual system components and functionality per room type empowering trainees to analyze potential malfunctions, troubleshoot issues and recommend modifications or additions.
 - c. Printed reference material for each attending trainee (written in plain language) addressing technical operation, adjustment, and programming, system features,

- system block diagrams, and as-built drawings.
- d. Review of the quick reference guide per room type.
- e. Demonstration of control system functionality per room type.
- f. Question and answer session.
- D. Training sessions to be scheduled in coordinated with the Owner after approval of formal training plans and occurring no more than six months after substantial completion.
 - 1. Complete operations and maintenance manuals and preliminary as-built drawings will be delivered to the Owner one week prior to the first scheduled training session.

3.9 WARRANTY

- A. The Contractor will warrant the system for parts and labor for one year.
 - 1. Warranty commences at the time of substantial project completion acceptance by Owner.
 - 2. Nothing will be construed to limit this obligation to a shorter period.
- B. Warranty service will be rendered on-site at the request of Owner to repair or replace any defective materials, equipment and/or workmanship without cost to the Owner unless the Owner has previously given the Contractor a written acceptance of such condition.
 - 1. The Owner will give prompt notice of the defect(s) either verbally or in writing to Contractor.
- C. Once every six months following the of date of substantial completion, the Contractor will provide on-site maintenance to make adjustments which suit actual occupied conditions and optimize performance of the installed equipment including (but not limited to):
 - 1. Inspecting of all components for proper operation and installation
 - 2. Cleaning of equipment that features an air intake, filter, or fan
 - 3. Checking and testing cable connections/terminations
 - 4. Analyzing control system presets and graphic user interface design based on feedback from Owner
 - 5. Recommend changes to the audiovisual system to improve Owner's utilization of the system
- D. Contractor will coordinate with the Owner to schedule the performance of required six-month on-site maintenance and include confirmation of that scheduling coordination as part of the Project close out documentation.
- E. Contractor will coordinate with the Owner on scheduling service technicians (who will check in and check out with Owner at the beginning and end of each visit) to perform maintenance/warranty work.
- F. Within two business days after the completion of the on-site maintenance/warranty service, the Contractor will provide the Owner a written report including (but not limited to) work performed, equipment repaired or replaced, and recommended audiovisual system updates or modifications.
- G. In the event of an equipment failure which cannot be repaired on-site, the Contractor will make a reasonable effort to provide the Owner with temporary equipment to maintain audiovisual system functionality.
- H. General Repair or Replacement Service
 - 1. Repair or replacement service during the warranty period will be performed five days a week and during Contractor's normal business hours with a four-hour response time.
 - 2. If the Contractor cannot restore system operation during the warranty period within two business days of the system failure, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
- I. Emergency Repair or Replacement Service
 - 1. Provide the Owner optional repair or replacement service pricing for emergency level work to be performed seven days a week and twenty hours a day with a one-hour response time as part of the Bid Response package.
- J. Extended Audiovisual System Support
 - 1. Provide the Owner optional extended service agreement pricing, terms, and conditions to support and maintain the audiovisual system during years two through five after the final acceptance date as part of the Bid Response package.

3.10 SUBSTANTIAL COMPLETION

- A. Work must meet the following requirements to qualify for the Owner's consideration of Substantial Completion:
 - 1. All audiovisual system devices will be completely installed, powered, online and operational.
 - 2. All sub-system interfaces must be complete and operational.
 - 3. Initial training schedule submitted.
 - 4. Owner may utilize the system for its designed intent.
- B. Contractor will provide a list of remaining work items and approximate completion date(s).
- C. Contractor will certify in writing that all remaining work is minor in nature and will be completed in less than thirty days.

3.11 TESTING REQUIREMENTS

- A. Audio Performance
 - 1. Harmonic Distortion
 - a. Measure the total harmonic distortion of the audio system. The distortion level should not exceed industry best practices, result in an audible hiss, or create audible noise at any system gain level.
 - 2. Signal-to-Noise
 - a. Measure the signal-to-noise ratio of the audio system. The noise level should not exceed industry best practices, result in an audible hiss, or create audible noise at any system gain level.
 - 3. Frequency Response
 - a. Measure the system's frequency response for speech sound reinforcement, which should be determined during design. Also measure frequency response for program sound amplification.
 - 4. Speaker Polarity
 - a. Program loudspeakers in the same system should produce consistent polarity for a mono input signal in all channels. Speech reinforcement systems should be polarized so that positive acoustic pressure on a microphone will result in positive acoustic pressure at all loudspeakers.
 - 5. Multiple Sources
 - a. Calibrate audio system inputs so that there is zero or minimal difference between any input signal level.
 - 6. Conferencing Systems
 - a. When working on a conferencing system, adjust the microphone input gain to demonstrate that a standard talker, positioned at each talker position in the room, produces a dBu level of zero at the output bus of the digital signal processor. Verify signal levels for both transmitting and receiving normal speech.
 - 7. Amplifier Loads
 - a. Make sure no power amplifier exceeds its rated load. Record the impedance (and at what frequency) for each loudspeaker line of each power amp. If available, 63, 250, and 1,000 Hz are recommended.
- B. Video Performance
 - 1. NTSC Signal Gain
 - a. For NTSC sources, you should demonstrate that a consistent, 1-volt, peak-to-peak test signal at each source produces a 1-volt, peak-to-peak to each destination. Verify at each destination using NTSC bars, peak white, and five-step multiburst.
 - 2. Projected Displays
 - a. Verify that projected displays are focused, centered, and evenly illuminated. Using a light meter, make sure a projected image has uniform brightness across the whole image, and measure the contrast ratio with ambient lighting in normal operating mode.
 - 3. Multiple Resolutions
 - a. The video system should be able to display stable, properly scaled images with no

artifacts when switching among, at minimum, 720p, 1080i, and 1080p sources, plus all sources in the performance criteria.

- C. The Contractor will perform sample tests in the presence of the Consultant and Owner.
 - 1. All testing will comply with EIA/TIA Standards and that of the equipment manufacturers.
 - 2. Performing the testing procedures specified herein assures that the communications cabling and system electronics meets the specified performance characteristics.
 - 3. If testing indicates that the performance characteristics are not met, the test will be considered "failed" and any other test that may be affected by the modification and/or repair will be re-run and verified.
- D. The Contractor will provide testing equipment to certify 100% operational condition of all audiovisual system cabling, components, and programming.
- E. The Contractor will prepare and submit all test procedures, forms and results to the Owner and Consultant.
 - 1. The test procedures will have Owner and Consultant approval before the testing begins.

3.12 SYSTEM CHECK-OUT AND VERIFICATION

- A. Verify continuity of cabling between field devices and controllers.
- B. Commission all devices from field to front end.
- C. Contractor supplied "As-Built" Drawings will show conduit routing.
- D. Review all As-Built documentation and Operation and Maintenance manuals with Owner.
 - 1. Revise and reissue as required.
- E. Provide As-Built/Record Drawing documentation in PDF and AutoCAD formats.
- F. Demonstrate proper sequences of operation for all devices.

3.13 FINAL ACCEPTANCE OF SYSTEMS

- A. Each area of construction submitted as "complete" will meet the following criteria under testing:
 - 1. System must meet all specifications as described in these instructions.
 - 2. Operational prints, manuals, signal logs and As-Built prints must be furnished.
 - 3. Visual testing and signal verification will be conducted at random locations to determine that equipment performs satisfactorily.
- B. Specifications set forth for construction of the system have been produced to ensure system compatibility and performance.
 - 1. Compliance to these specifications will be determined during periodic observances of construction.
 - 2. Repeated failure to comply with the specifications will be considered before the acceptance phase of the Project commences.
- C. Within ten days receipt of the final acceptance notice, the Owner's representatives will schedule and perform the final inspection.
 - 1. Declaration that the Project is "complete" will be achieved when the work is found acceptable under the contract documents and that the contract has been fully performed.

END OF SECTION 27 4100

**SECTION 28 0500
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY**

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. 280500 Electronic Safety and Security
- B. 281300 Access Control
- C. 282300 Video Surveillance

1.2 DESCRIPTION

- A. This Section, Requirements for Electronic Safety and Security Installations, applies to all sections of Division 28.
- B. Furnish and install electronic safety and security cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of cable and other items and arrangements for the specified items are shown on drawings.

1.3 REFERENCE STANDARDS

- A. Adherence to and compliance with the codes and standards referenced and the UNT, unique requirements, and design solutions is mandatory. Requests to deviate from the industry standards and design solutions prescribed in these guidelines may be submitted on a case-by-case basis in accordance with the instructions in the Policy and Procedures section of these guidelines. No deviation from the requirements of the National Electrical Code (NEC) will be allowed.

1.4 CODES, STANDARDS, REFERENCES, AND APPLICABILITY

- A. National Electrical Code, NFPA 70.
 - 1. The National Fire Protection Association has acted as the sponsor of the National Electrical Code (NEC) since 1911. The original Code was developed in 1897 as a result of the united efforts of various insurance, electrical, architectural, and allied interests. The purpose of the NEC is the practical safeguarding of persons and property from hazards arising from the use of electricity. The NEC provides the minimum code requirements for electrical safety. In security distribution design, the NEC must be used in concert with the ANSI/EIA/TIA standards identified below, which are intended to ensure the performance of the security infrastructure.
- B. TIA Standards
 - 1. The Telecommunications Industry Association (TIA) engineering standards and publications are designed to serve the public interest by eliminating misunderstandings between manufacturers and purchasers. The standards facilitate the interchangeability and improvement of products and assist the purchaser in selecting and obtaining the proper product for his or her particular need.
- C. Cabling Standard, ANSI/TIA-568-C (SERIES)
 - 1. The ANSI/TIA-568-C (series) is the Commercial Building Cabling Standard. This standard defines a generic security wiring system for commercial buildings supporting a multi-product, multi-vendor environment. It also provides direction for the design of security cabling products for commercial enterprises.
 - a. The purpose of the standard is to enable the planning and installation of building wiring with little knowledge of the security products that subsequently will be installed. Installation of wiring systems during building construction or renovation is significantly less expensive and less disruptive than after the building is occupied. ANSI/TIA-568-C establishes performance and technical criteria for various wiring system

configurations for interfacing and connecting their respective elements.

D. Pathways and Spaces, ANSI/TIA-569-C (SERIES).

1. The ANSI/TIA-569-C (series) is the Commercial Building Standard for Pathways and Spaces. This standard will be followed at the UNT and recognizes three fundamental concepts:
 - a. Buildings are dynamic. Over the life of a building or campus, remodeling is more of a rule than an exception. The standard recognizes that changes will take place.
 - b. Building security systems and media are dynamic. Security equipment and cabling change dramatically over the life of a building or campus. The standard recognizes this fact by being as independent as possible from specific vendor equipment and media.
 - c. Security is more than just locks and cameras. Security encompasses many building systems, including environmental controls, fire alarms, and emergency paging.
 - d. To have a building or campus successfully designed, constructed, and provisioned for Security, the security design must be incorporated during the preliminary architectural design phase. The architect must work closely with the designated Security & IT staff members to accomplish this.

E. Grounding and Bonding, ANSI-J-STD-607-B (SERIES)

1. The ANSI/TIA-607-B (series) (also known as ANSI J-STD-607-B) is the Commercial Building Grounding and Bonding Requirements for Security. The National Electrical Code (NEC) provides grounding, bonding, and electrical protection requirements to ensure life safety. Modern security systems require an effective grounding infrastructure to ensure optimum performance of the wide variety of electronic security systems that may be used throughout the life of a building. The grounding and bonding requirements of this standard are additional technical security requirements beyond the scope of the NEC. These standards are intended to work in concert with the cabling topology specified in ANSI/TIA-568-C and installed in the pathways and spaces designed in accordance with ANSI/TIA-569-C.

F. Americans With Disabilities ACT (ADA)

1. The Americans with Disabilities Act defines accessible design considerations such as spacing between equipment, room layouts, mounting heights, and device and communications requirements applicable to Electronic Safety and Security designs and installations. It also contains regulations concerning alarms and signage.

G. Occupational Safety & Health Administration (OSHA)

1. Through the Occupational Safety and Health Administration, the federal government enforces the safety aspects of codes and standards that apply to employees' working conditions. Guidelines for good practice when installing electronic safety and security systems are defined in the following documents:
 - a. 29CFR1910, Title 29, Labor-Part 1910 OSHA Standards.
 - 1) 29CFR1926, Title 29, Labor-Part 1926 Safety & Health Regulations for Construction.
 - 2) Individual states may have their occupational safety divisions. Most states or localities accept certification of electrical products by a national testing laboratory as evidence that products and materials are safe for use in that jurisdiction.

H. Underwriters Laboratories Inc. (UL)

1. In the United States, the Authority Having Jurisdiction (AHJ) typically requires UL testing and certification on electrical equipment. Some of the applicable standards are as shown below:
 - a. UL 294 (1999) Standard for Access Control System Units. UL 639 (1997) Standard for Intrusion-Detection Units.

I. BICSI Electronic Safety & Security Design Reference Manual

1. The Building Industry Consulting Service International, Inc. (BICSI) is an information technology association whose mission is to provide the industry with state-of-the-art information technology and security knowledge, resulting in good service to the end user.

BICSI develops and publishes the Electronic Safety and Security Design Reference Manual (ESSDRM). The ESSDRM is not a code or standard. The ESSDRM is an extensive volume of information on various security systems and distribution aspects.

- a. The ESSDRM provides discussions and examples of various engineering methods and design solutions that can be selected and employed in order to meet the requirements of the NFPA and ANSI/TIA standards. Designers and installers are encouraged to use the ESSDRM as an engineering tool within the constraints of the UNT Security Infrastructure Standards requirements.

1.5 MINIMUM REQUIREMENTS

- A. References to industry and trade association standards and codes are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.
- C. Access control systems shall be designed and installed to neither interfere with egress requirements for life safety nor with intrusion or fire alarm systems.
- D. All access-controlled handicap entrances shall be fully integrated into the building access control system, ensuring that while providing access to the disabled, proper access control is maintained in both the unsecured and secured modes. Access control systems shall be installed to comply with the Americans with Disabilities Act and UNHSC policies.
- E. All access control installations shall use housings and mountings that maintain or minimize disruption to the buildings and campus's architectural sensibilities or themes.
- F. All access control installations shall use housings and mounting designed to provide sufficient protection against tampering and vandalism. Torx center pin security fasteners shall be used on all devices installed in public areas.
- G. All equipment and components to support the access control system shall be installed to the manufacturer's specifications. Installation of components and hardware shall be in place prior to connection to the access control system.
- H. Installations of control access system equipment hardware shall comply with requirements found in UNHSC Construction Standards.
- I. All access control systems shall be configured to provide a Fail Secure with mechanical manual egress from the secure side in case of a loss of power, network communications, or system failure.
- J. All access control equipped door locking hardware shall include keyed locking mechanisms accessible from the unsecured side to allow keyed manual operation of the door.
- K. All access control-equipped doors shall be keyed to a key system designated for access-controlled doorways.
- L. All access control doors shall be equipped with door position monitors and request-to-exit devices to allow for the configuration of door condition alarms.
- M. All access-controlled system equipment, including controllers and power supplies, shall be located in accessible and secure rooms, with Telecommunication/ IDF rooms being preferred.
- N. Electric power supplies and power converters for the access system equipment and hardware shall be connected in the Telecommunications/IDF room. Power supplies located at the access-equipped door should be avoided.
- O. Electrical service to access control power supplies shall be on dedicated circuits. Where practicable, the building emergency power supply should provide electric power for the access system.

- P. All access control equipment power supplies shall be equipped with battery backup to allow operation if electrical service and emergency-generated power are lost.
- Q. As a minimum, provide a conduit from all access devices, hardware, and equipment to the ceiling location to allow convenient access to raceways for cabling.
- R. All new construction installation of access control systems shall be hardwired. Hardwired installations are preferred in renovation or retrofit installations; wireless systems may be considered with the approval of Access Services, the Project Manager, and the building owner.
- S. Wiring Connection Requirements: All low-voltage control, monitor, power, and other cables shall be connected using sealed crimp-type lugs; no wire nuts will be allowed.
- T. Monitor Contacts: Door monitoring contacts, wiring, and conduits shall be concealed and invisible when the door is closed. Externally applied door monitoring contacts, externally applied conduit or wire mold, and Access Services, the Project Manager, and the building owner must approve wire without conduit.
- U. Request to Exit Switches: Request to exit (RX) switches should be mechanically hardware-based devices. Passive infrared (PIR) or sonic detectors must not be used.

PART 2 PRODUCTS

2.1 GENERAL

- A. Manufacturers' Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project and shall have manufactured the item for at least three years.
- B. Product Qualification:
 - 1. The manufacturer's product shall have been in satisfactory operation on three installations of similar size and type as this project for approximately three years.
 - 2. The University reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- C. Service Qualifications: A permanent service organization maintained or trained by the manufacturer shall render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit the name and address of service organizations.

2.2 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in manufacturing such items, for which replacement parts shall be available.
- B. When more than one unit of the same equipment class is required, such units shall be a single manufacturer's product.
- C. Equipment Assemblies and Components:
 - 1. Components of an assembled unit need not be products of the same manufacturer.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. Components shall be compatible with each other and the total assembly for the intended service.
 - 4. Constituent parts that are similar shall be a single manufacturer's product.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 - 1. The Owner shall have the option of witnessing factory tests. The Contractor shall notify UNT through the Construction Manager a minimum of 15 working days prior to the manufacturers making the factory tests.

2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory tests and re-inspection is required, the Contractor shall be liable for all additional expenses, including expenses of the University.

2.3 EQUIPMENT REQUIREMENTS

- A. Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and Section 01 33 23, Shop Drawings, Product Data, And Samples, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels, and installation methods.

2.4 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold, and rain:
 1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items shall be protected against entry of foreign matter and be vacuum cleaned both inside and outside before testing, operating, and repainting if required.
 2. Damaged equipment shall be, as determined by the Resident Engineer, placed in first-class operating condition or returned to the supply source for repair or replacement.
 3. Painted surfaces shall be protected with factory-installed removable heavy kraft paper, sheet vinyl, or equal.
 4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so that repaired areas are not obvious.

PART 3 EXECUTION

3.1 WORK PERFORMANCE

- A. Job site safety and worker safety are the responsibilities of the Contractor.
- B. For work on existing buildings, arrange, phase, and perform work always to ensure electronic safety and security service for other buildings. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- C. The Contractor's Project Manager shall attend a pre-installation meeting with the Owner and design team prior to working on the project.
- D. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- E. Coordinate equipment location and conduit with other trades to minimize interferences. See Section 00 72 00, GENERAL CONDITIONS.

3.2 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 1. Where the University determines that the Contractor has installed equipment that is not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the University.
 2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit, and raceways.

3.3 EQUIPMENT IDENTIFICATION

- A. Install an identification sign that clearly indicates the information required for the use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, at least 6 mm (1/4 inch) high—secure nameplates with screws. Nameplates furnished by the manufacturer as a standard catalog item or where another identification method is herein specified are exceptions.

3.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The University's approval shall be obtained for all equipment and materials before delivery to the job site. Delivery, storage, or installation of equipment or material without prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the University to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify the submitted equipment.
- D. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals, including the section and paragraph numbers, shall be marked to show specification reference.
 - 3. Submit each section separately.
- E. The submittals shall include the following:
 - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data, and test reports as required.
 - 2. Elementary and interconnection wiring diagrams for communication and signal systems, control systems, and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
 - 3. Parts list, which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price, and availability of each part.
- F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
 - 1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies bound in hardback binders (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to the performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
 - 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
 - 3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 - 4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.

- c. Description of the function of each principal item of equipment.
 - d. Installation and maintenance instructions.
 - e. Safety precautions.
 - f. Diagrams and illustrations.
 - g. Testing methods.
 - h. Performance data.
 - i. The pictorial "exploded" parts list has part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and the name of the servicing organization.
 - j. Appendix: list qualified permanent servicing organizations for equipment support, including addresses and certified qualifications.
- G. Approvals will be based on the complete submission of manuals together with shop drawings.
- H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
- 1. A 300 mm (12 inches) length of each type and size of wire and cable, along with the tag from the coils of reels from which the samples were taken.
 - 2. Each conduit and pathway coupling, bushing, and termination fitting type.
 - 3. Conduit hangers, clamps and supports.
 - 4. Duct sealing compound.

3.5 SINGULAR NUMBER

- A. Where any device or part of the equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

3.6 TRAINING

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
- B. Training shall be provided for the equipment or system as required in each associated specification.
- C. A training schedule shall be developed and submitted by the Contractor and approved by the Resident Engineer at least 30 days prior to the planned training.

END OF SECTION 280500

**SECTION 28 1300
ACCESS CONTROL**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Security access devices.
- B. Access control panel.
- C. Intercom System

1.2 RELATED SECTIONS

- A. Section 087100 - Door Hardware.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.
- B. UL 294, "Standard for Access Control System Units"
- C. UL 1076, "Standard for Proprietary Burglar"
- D. UL 916, "Standard for Safety for Energy Management Equipment"

1.4 ACCESS CONTROL

- A. All access control and intrusion detection components shall be the most current model or version available and shall be compatible and interoperable with other installed systems such as digital video management, fire alarm, and building environmental control systems. The system shall be an IP-based open architecture type system that facilitates monitoring from numerous workstations throughout the system. The system shall provide an interface with client workstations in police offices on each individual campus and with the police dispatch center located on the Northeast campus.
- B. The Access Control system consists of sub-systems such as Access Control and Intrusion Detection servers, workstations and software, data gathering panels, LAN interface cards, card readers, door position sensors, and request-to-exit devices. The system shall allow for controlled entrances to be programmed to lock and unlock on a predetermined schedule. The security integrator shall coordinate with campus personnel to ascertain the desired door scheduling and program the system to meet the schedule. Each time an entry is made with a valid credential, the system shall record and store that information on the server to provide an audit trail of when a door was opened (date and time) and whose credential was presented for access (user's name and card number). The system shall also record and store the date and time of each alarm occurrence of a door being opened without the presentation of a valid credential or when a door remains open for longer than a preset time programmed in the software. This information shall be continuously displayed on server and workstation monitors and shall be recallable and printable from these stations. It is the responsibility of the security integrator to verify the proper operation of devices and systems prior to final acceptance.
- C. The card readers shall be proximity readers and be programmable from a server or workstation equipped with security software. Card readers shall work such that upon

presentation of a valid credential, the unique card data shall be transmitted to an associated control panel where the data is compared to an authorized user database, and access is approved or rejected accordingly. A valid authorization will activate the operation of the electric lock and shunt the door status switch. The alarm shunt will not affect the supervision of the detection circuit.

1.5 SYSTEM DESCRIPTION

- A. Security Access System: Control access to the building using encoded cards:
 - 1. Selected Exterior Doors: Control access into the building.
 - 2. Selected Building Areas: Control access into restricted areas.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Provide a system wiring diagram showing each device and the required wiring connection.
- C. Product Data: Provide electrical characteristics and connection requirements.
- D. Test Reports: Indicate satisfactory completion of required tests and inspections.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by the product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Project Record Documents: Record actual locations of access authorization equipment.
- G. Operation Data: Operating instructions.
- H. Maintenance Data: Maintenance and repair procedures.

1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of three years of documented experience and with service facilities within 100 miles of the Project.
- C. Installer Qualifications: The company specializing in installing the products specified in this section must have a minimum of three years of documented experience and **MUST** be a Schneider Electric partner.
- D. Products: Furnished products are listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of the security access system for one year from the Date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. See Section 01 60 00 - Product Requirements for additional provisions.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Security Access Control System:
 - 1. Access Expert

2.2 COMPONENTS

- A. Security Access Control Client License:
 - 1. Product: Access Expert
 - 2. Substitutions: Not allowed.
- B. Encoded Card Readers:
 - 1. Product: Schlage MTMS15
 - 2. Product: Schlage MTMSK15 W/Keypad
- C. PIR Exit Devices:
 - 1. Product: Bosch DS160.
 - 2. Substitutions: Not allowed.
- D. Intelligent System Controllers:
 - 1. Product: AX-LP1501
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- E. Electric Locks:
 - 1. Refer to the door hardware specification section.
- F. Single Door Module:
 - 1. Product: AX-MR50-S3
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- G. Dual Door Module:
 - 1. Product: AX-MR52-S3
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- H. Input Boards:
 - 1. Product: AX-MR16IN-S3
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- I. Relay Output Boards:
 - 1. Product: AX-MR16OUT-S3
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- J. Power Supplies:
 - 1. Product: Altronix
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- K. Card Access Cable:
 - 1. Product: Belden B658AFS.
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- L. Single PoE Reader Interface Module:
 - 1. Product: AX-MR62E
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with the manufacturer's instructions.
- B. Use 16 AWG minimum-size conductors for detection and signal circuit conductors. Install wiring in conduit.
- C. Make conduit and wiring connections to door hardware devices furnished and installed under Section 08 7100.

3.2 DEVICE POSITIONING

- A. Card readers shall be installed at an ADA-compliant height of 42" above grade. The door position sensors shall be concealed, flush-mounted units mounted on the top of the door frame approximately 4 to 6 inches from the opening edge of the door.

3.3 TEST PROCEDURES

- A. Field Test Reports: Upon completion and testing of the installed system, test reports shall be submitted in booklet form and electronic media showing all field tests performed on and adjustments made to each/any component and all field tests conducted to prove compliance with the specified performance criteria. Indicate and interpret test results in written form and verbally to owner/4b Technology for compliance with performance requirements at a pre-scheduled meeting.
 - 1. Specific test and verification requirements by demonstration or test are as follows. The owner reserves the right to witness any and all tests.
 - a. Following factory assembly and delivery, the security subcontractor shall individually test each component and sensor and verify the proper functioning of each element within a particular sub-system.
 - b. Following installation, individually test each component and sensor and verify the proper functioning of each element within a particular sub-system. Similarly, test each sub-system until all detection zones, alarm assessment components, alarm reporting and display, and access control functions have been verified. Prior to final functional and operational tests of the system, correct any deficiencies. After sub-system verification is complete, test the entire system to ensure that all elements are compatible and function properly as a whole system.
 - c. Upon completion of the above-outlined tests, conduct a formal test to be known as the "System Operational Test," in which all components and sub-systems of the security system are demonstrated to operate together as a system. This test is to be performed over a continuous seventy-two (72) hour period. A formal test plan and test procedures for each portion of the test shall be prepared by the security subcontractor and submitted to the Owner/Architect for approval. The subcontractor must demonstrate that the security system components and sub-systems meet specification requirements in the "As-Installed" operating environment during the "System Operational Test." While no formal environmental testing is required, temperature, humidity, and other environmental parameters should be measured and recorded. Include this data in the test report document for the "System Operational Test."

3.4 FIELD QUALITY CONTROL

- A. Perform field inspection and testing per Section 01 40 00.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Include the services of a technician to supervise installation, adjustments, final connections, system testing, and training of UNT personnel.

3.6 DEMONSTRATION

- A. Demonstrate normal and abnormal modes of operation and the required response to each.
- B. Provide 8 hours of instruction each for two people.
 - 1. Conduct instruction at the project site with the manufacturer's representative.
 - 2. Include travel and living expenses for UNT personnel.

END OF SECTION 281300

**SECTION 28 2300
VIDEO SURVEILLANCE**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cameras.
- B. Control equipment.
- C. Cable and accessories.

1.2 RELATED SECTIONS

- A. Section 281300 - Access Control.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. The UNT video surveillance system is an Internet Protocol (IP) camera-based system that runs off of signal and low voltage power generated by a Power over Ethernet (PoE) data network switch and using signals transmitted over Local and Wide Area Network cable.
- B. All cabling used for camera image transmission is the same type used for high-end data networks, Category 6A Unshielded Twisted Pair copper. Communications specifications sections should be adhered to for the installation of Category 6A cabling.
- C. Camera data is recorded and viewed from an existing central storage device.
- D. Camera software licenses may be required to add additional cameras to the existing system.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements, including system wiring diagram.
- C. Product Data: Provide a showing of each component's electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by the product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual locations of cameras and routing of television cable.
- F. Operation Data: Instructions for starting and operating the system.
- G. Maintenance Data: Routine troubleshooting procedures.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of three years of documented experience and with service facilities within 100 miles of the Project.
- C. Supplier Qualifications: Authorized distributor of specified manufacturer with a minimum of three years of documented experience.
- D. Installer Qualifications: Authorized installer of the specified manufacturer with service facilities within 100 miles of the Project.
- E. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 MAINTENANCE SERVICE

- A. Furnish service and maintenance of the television system for one year from the Date of Substantial Completion.

PART 2 PRODUCTS

2.1 COMPONENTS - CAMERAS

- A. Indoor fixed: Avidia M-45-FW-V2
- B. Outdoor Fixed: Avidia M-46-FW-V2
- C. Indoor Dual Sensor: IPRO WV-U85402-V2L

2.2 ACCESSORIES

- A. Camera Mounts
 - 1. Mount bracket: Dual sensor device WV-QSR507F1-W
- B. Main Video Cable: Category 6A
 - 1. Product: As determined by Section 27 15 00.
- C. Cabinet: Free-standing equipment rack (Provided by Communications Installer).
 - 1. Size: As indicated.

2.3 VMS, LICENSES AND STORAGE

- A. Video Management System – Video Insight 7
- B. Provide all camera licenses as required for a fully functional system
- C. Provide a quote for a Video Insight IP Server and storage to allow for 30 days of storage at 16 hours of motion per day to estimate total storage needs.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install per the manufacturer's instructions.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Interface installation of video surveillance with security access and intrusion detection systems.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of the manufacturer's technical representative to prepare and start systems and supervise final wiring connections and system adjustments.

3.4 ADJUSTING

- A. Adjust manual lens irises to meet lighting conditions.

3.5 DEMONSTRATION

- A. Demonstrate system operation and provide two hours of instruction with manufacturer's training personnel.
- B. Conduct a walking tour of the Project and briefly describe each component's function, operation, and maintenance.

END OF SECTION 282300

SECTION 28 3107
EXTENSION OF EXISTING FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division and as shown on the Contract Drawings. This section expands and supplements the requirements of Division 01.
- C. Refer to Section 26 0510 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK.

1.02 SCOPE

- A. The work covered by this section of the specifications includes the furnishing of all design, labor, equipment, materials, programming, testing and performances of all operations in connection with the extension of the existing Notifier addressable fire alarm system as shown on the drawings, as specified herein, and as required by City of Fort Worth Fire Department, and the Texas Department of Licensing and Regulation Texas Accessibility Standards.
- B. The complete installation shall conform to the applicable section of NFPA-72A, NFPA 71, local code requirements and National Electrical Code Article 760.
- C. The work covered by this section of the specifications shall be coordinated with the related work as specified elsewhere under the project specifications.

1.03 QUALITY ASSURANCE

- A. Each and all items of the fire alarm system shall be listed as a product of Notifier by Honeywell under the appropriate category by Underwriter's Laboratories, Inc. (UL), and shall bear the UL label. All control equipment shall be listed under UL Category 1076 as a single control unit. Partial listing shall NOT be acceptable.
- B. Qualifications of the Installer
 - 1. The installing contractor shall specialize in the design and installation of fire alarm systems. The firm shall have a minimum of three years of verifiable commercial fire alarm system design and installation experience.
 - 2. State License. The firm shall be registered as a fire alarm contractor Alarm Certificate of Registration (ACR) with the Texas State Board of Insurance Underwriters (TDI) and have in its employ, a Fire Alarm Planning Superintendent (APS), licensed by the Texas State Board of Insurance Underwriters (TDI); and Fire Alarm Technician(s) (FAL), licensed by the Texas State Board of Insurance Underwriters (TDI). The firm shall also be an authorized NOTIFIER® authorized distributor.

3. Installer Qualifications: Installer(s) must be Fire Alarm Technician (FAL), licensed by the Texas State Board of Insurance Underwriters (TDI), and be a certified NOTIFIER® equipment technician.
 4. Insurance: The installing firm shall carry liability insurance in the amount and manner specified by the Texas State Board of Insurance Underwriters (TDI) to install fire alarm systems.
 5. All fire alarm panel, ONYXWorks® and their associated programming shall be done by a NOTIFIER® certified technician.
 6. Before commencing work, the installing contractor shall submit data showing that the contractor has successfully installed fire alarm systems of the same type and design as specified, or that they have a firm contractual agreement with a state licensing subcontractor having the above required manufacturer's training and experience. The contractor shall include the names and locations of at least two installations where the contractor, or the subcontractor above, has installed such systems. Specify the type and design for each system and furnish documentation that the systems have performed satisfactorily for the preceding 18 months.
- C. Provide the Owner's Representative with:
1. Manufacturer's certificate showing materials meet or exceed the minimum requirements as specified.
 2. A copy of installing company's license to sell and install fire alarm systems in the State of Texas.
 3. A copy of job superintendent's license to supervise installation of fire alarm systems in the State of Texas.
 4. Shop drawings and wiring diagrams with equipment counts and locations shall be submitted to the local authority for approval and signature prior to submitting to Engineer through proper channels. The shop drawings must be approved by the Engineer prior to commencing work. Room names must be shown on shop drawings.

1.04 GENERAL

- A. Furnish and install a modification to the existing fire alarm system as described herein and as shown on the plans; to be wired, connected and left in first class operating condition. The system shall include all required hardware, raceways, wiring and software to accomplish the requirements of this specification.

1.05 REFERENCE STANDARDS

- A. The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version
 1. Texas Department of Insurance (TDI) State Fire Marshal's Office;

2. National Fire Protection Association (NFPA):
 - a. NFPA 72 Standard for the Installation, Maintenance and use of Protective Signaling Systems;
 - b. NFPA 13 Standard for the Installation of Sprinkler Systems;
 - c. NFPA 70 National Electrical Code;
 - d. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems;
 - e. NFPA 101 - Life Safety Code.
3. Texas Insurance Code Chapter 6002, Fire Detection and Alarm Device Installation;
4. 28 TAC §§ 34.600 The Fire Alarm Rules;
5. Underwriter's Laboratories, Inc. (UL);
6. Texas Accessibility Standards (TAS);
7. UNTHSC Specifications.

1.06 SUBMITTALS

- A. The contracting firm shall submit copies of its Texas Department of Insurance (TDI) Fire Alarm Contractor Registration (ACR), Fire Alarm Planning Superintendent License (APS) and the required TDI's Liability Insurance Certificate, signed by a Texas Insurance Agent.
- B. The contractor shall include the following information in the equipment submittal;
 1. Power calculations.
 - a. Battery capacity calculations. Batteries shall be sized at least 150% of the calculated requirement.
 - b. Supervisory power requirements for all equipment.
 - c. Alarm power requirements for all equipment.
 - d. 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.
 - e. Justification showing power requirements of the system amplifiers.
 - f. Voltage drop calculations for wiring runs demonstrating worst case condition.
 2. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

3. 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 submittals will not be evaluated and will be rejected without comment.
 4. Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product coverage and performance. At a minimum, data shall be submitted on the following:
 - a. 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.
 - b. Circuit interface panels including all modules.
 - c. Power supplies, batteries, and battery chargers.
 - d. Pre-amplifiers, amplifiers, tone generators, master microphone and master telephone.
 - e. Equipment enclosures, including dimensions and weights of completed units.
 - f. Intelligent addressable manual pull stations, heat detectors, analog smoke detectors, alarm monitoring modules, and supervised control modules.
 - g. Annunciator panels.
 - h. Audible and visual evacuation signals and devices.
 - i. Software and firmware as required to provide a complete functioning system.
 - j. Circuiting, including conduit and wire sizes.
 - k. All interface and connection with ONYXWorks® remote terminals - UNTHSC and Fire Systems Offices.
- C. Complete drawings covering the following shall be submitted by the contractor for the proposed system;
1. Floor plans showing all communicating, initiating, supervisory, indicating appliances, and output control devices; including circuit interface panels, message digitizers, amplifiers, annunciators, 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.
 - a. The FAAP, remote power supplies, electronic control boards and batteries shall be installed in rooms or locations where relative humidity is maintained at less than 90% and temperature is maintained between 60° - 80° F.
 2. Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.

- D. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a CD ROM and in a formatted printed form, as required for offsite 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.
- E. For use in system test, a complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.
 - 1. The following information shall be inscribed on the cover:
 - a. "OPERATION AND MAINTENANCE MANUAL"
 - b. Building Name and address
 - c. The name of the fire alarm firm/contractor, Alarm Planning Superintendent and alarm system manufacturer.
 - 2. The manual shall be legible and easily read with a full size copy of record drawings folded and contained in pockets. Included shall be installation instruction, maintenance documentation.
- F. Upon completion of the installation, record drawings shall be submitted on each system before final acceptance of the work. In addition to the records drawings masters shall be high quality for legibility and reproduction and on high density CD ROM in an AutoCAD DXF format.

PART 2 - PRODUCTS

2.01 FIRE ALARM SYSTEM AND REMOTE POWER SUPPLIES

- A. System Operation: Refer to UNT System Design and Construction Standards for system operation requirements.

2.02 REMOTE CIRCUIT INTERFACE PANELS

- A. 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.
 - 1. 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.
 - 2. 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.
 - 3. 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.

2.03 DETECTOR BASES

- A. Detector Bases - Detector bases for public areas shall be low profile, surface or flush mounted on a standard 4" square by 2-1/8" deep box. Bases shall be able to accept photoelectric, ionization or heat detectors.
- B. Detector Bases for sleeping/dwelling units shall be sounder bases for all system smoke detectors located in sleeping/dwelling units. Sounders shall produce a low frequency 520 Hertz \pm 10% frequency alarm signal that complies with NFPA 72 Section 18.4.5.

2.04 SMOKE DETECTORS - PHOTOELECTRIC

- A. Furnish and install intelligent analog photoelectric smoke detectors in accordance with NFPA 72, in all sleeping/dwelling units and public areas and where indicated on the drawings.
 - 1. Manufacturers:
 - a. Detector shall be campus standard System Sensor, no exception.

2.05 DUCT DETECTORS - PHOTOELECTRIC

- A. Furnish and install where indicated on the drawings, intelligent analog smoke detectors.
 - 1. Manufacturers:
 - a. Detector shall be campus standard System Sensor, no exception.
 - 1) If mounted where the detector is not readily accessible or within normal view, a remote visual indicator and control for testing and re-setting unit shall be installed in close proximity in a readily accessible, viewable location.

2.06 HEAT DETECTORS, INTELLIGENT RATE COMPENSATED

- A. Furnish and install where indicated on the drawings, intelligent analog smoke detectors.
 - 1. Manufacturer:
 - 2. Detectors shall be campus standard System Sensor, no exception.

2.07 MANUAL STATIONS, INTELLIGENT

- A. Provide double action, intelligent, manual fire alarm "Pull Stations" where shown on the plans. Pull stations shall be:
 - 1. Manufacturer:
 - a. Pull Stations shall be campus standard NOTIFIER®, no exception, and shall be:
 - 1) red in color;
 - 2) provide a clear indication when activated;
 - 3) labeled "FIRE"

- 4) equipped with terminal strip and pressure style screw terminals for the connection of field wiring;
- 5) flush mounted.

2.08 MAGNETIC HOLD OPEN DEVICE

- A. Provide 24 VDC magnetic hold open devices where indicated in architectural door hardware specification. Devices shall release upon activation of a fire alarm.

2.09 INTELLIGENT SYSTEM INTERFACE MODULE

- A. Furnish and install, for the monitoring of contact type initiation devices and for the control of electrical devices where required, intelligent analog signaling circuit interface module.
- B. The module shall be suitable for two wire, two way communications on the intelligent analog signaling circuit. The module shall display a flashing LED for each circuit, in the normal power or standby power condition. The module shall display a steady LED when the alarm state or during control circuit activation.
- C. Modules shall incorporate triple technology microprocessor chips including analog, digital and EEROM technologies on the single device.

2.10 EVACUATION SIGNALS

- A. Speakers: Shall be of the polarized 24-VSC 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. Settings shall be 1/16, 1/8, 1/4, 1/2, 1, 2, or 4 watts.
 1. Speech Intelligibility: The emergency voice communication system shall be designed to meet a Common Intelligibility: The emergency voice communication system shall be designed to meet a Common Intelligibility Scale (CIS) of not less than 0.70.
- B. Strobe Light: Visual notification appliances shall be comprised of a xenon flashtube and be entirely solid state. These devices shall be UL listed and available for ceiling or wall mounting. The unit shall be Texas Accessibility Standards (TAS) compliant with and output no less than 15 candela. The Lexan lens shall be pyramidal in shape to allow better visibility. All strobe lamps and lenses shall be clear. Strobe light vandela ratings shall be shown on the fire alarm plans. Contractor is responsible for providing number of strobes and candela sizing 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. 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.

- C. Speaker/Strobe combination: Units shall meet TAS. 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, Lexan lens visible from a 180-degree field of view. Strobe shall be multi-tap type to allow for a full range of candela. Xenon strobe shall provide 4-wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including back box. Audio/visual unit shall be UL listed for its intended purpose. Speaker shall be multi-tap type to allow for different audio settings. Provide spare devices equal to 1% of the total number of new devices provided for this project.
- D. The evacuation signal device shall be available in flush, semi-flush, or surface mount versions as required for signal locations shown on the contract documents. Devices shall be mounted using a listed outlet box. Signals shall be available in visual and audio/visual to satisfy all required project applications. Device housing shall be white and without any label.
- E. 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 key switch. All terminals shall be labeled to identify their function.
- F. The output contacts from the fire alarm system shall be rated for 1A at 120V.

PART 3 - EXECUTION

3.01 DESIGN AND INSTALLATION DRAWINGS

- A. Show a general layout of the complete system including equipment arrangement. It shall be the responsibility of the fire alarm contractor to verify dimensions and assure compatibility with all other systems interfacing with the fire alarm system.
 - 1. Identify on the drawings, conduit and conductor sizes and types with number of conductors in each conduit. Provide each conduit and device with a unique identification. For addressable alarm initiation devices, the system identifier shall be the system address for that device. Signals shall be sequentially numbered as the address of the controlling module.
 - 2. Indicate on the point to point wiring diagrams, interconnecting wiring within the panel between modules, and connecting wiring to the field device terminals.
 - 3. Provide mounting details of FACP and other boxes to building structure, showing fastener type, sizes, material and embedded depth where applicable.

3.02 INSTALLATION

- A. All work shall be in compliance with Section 1.3, REFERENCE STANDARDS contained in the UNT System Design and Construction Standards.
- B. All work shall be accomplished in a professional and workmanship like manner.
- C. A qualified fire alarm technician shall supervise the installation, testing and adjustment of the fire alarm equipment.

- D. The Fire Alarm contractor is responsible for patching and repairing walls and/or ceilings penetrations made by the fire alarm contractor or his/her designated subcontractor(s) where wiring, conduit or devices are installed or removed. Holes in smoke barrier or fire-resistive construction walls and ceilings shall be properly sealed with approved UL listed materials and/or UL listed fire stop/smoke devices designed for such use or location. The smoke or fire stop material or devices shall be approved by the wiring manufacturer for compatibility with the wiring material it contacts. Whichever method is approved, it shall be installed per the UL listing of the specific product.
- E. Contractor shall provide fire watch during all times that existing system coverage is down as a result of renovation work associated with this project.

3.03 CONDUITS

- A. All wiring shall be installed in conduit, minimum 3/4" EMT. Plenum rated cable with J-hooks may be used above ceiling.

3.04 ENCLOSURES AND WIRING DEVICES

- A. Wiring enclosures and equipment device boxes shall be sized and installed per NFPA 70.
 - 1. All fire alarm J-Boxes and their covers shall be painted red. The cover shall be labeled "FA System" in minimum 1/2 inch letters with permanent black ink.

3.05 CONDUCTORS

- A. All fire alarm systems shall be installed in such a manner that a failure of any single initiating device or single open in an initiating circuit conductor will not interfere with the normal operation of other such devices. All signaling line circuits (SLC) shall be installed such that a single open will not interfere with the operation of any addressable devices (Class A). Outgoing and return SLC conductors shall be installed in accordance with NFPA 72 requirements for Class A circuits and shall have a minimum of four feet separation horizontal and one foot vertical between supply and return circuit conductors. The initiating device circuit (IDC) from a signaling line circuit interface device may be wired Class B, provided the distance from the interface device to the initiating device is ten feet or less. NAC circuits shall be wired Class A.
- B. Each conductor shall be identified as shown on the shop drawings with wire markers at every splice and terminal point. Attach permanent wire markers within 2 inches of each wire termination. Marker legends shall be visible.
 - 1. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.
 - 2. Wiring for analog loop circuits and speaker circuits shall be minimum 18 AWG twisted. Wiring for strobe circuits shall be a minimum 14AWG.
 - 3. Wiring shall be installed without splices or joints. Connections shall be made to the device terminals or equipment terminal strip.

4. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- C. Permanently label or mark each conductor at each end and at all terminals with permanent alphanumeric wire markers.
- D. Provide Type CI, 2 hour rated circuit integrity cable for riser wiring and wherever else required per code.

3.06 CERTIFICATE OF COMPLIANCE

- A. Complete and submit to the Owner in accordance with NFPA 72.

3.07 FIELD QUALITY CONTROL

- A. Testing, General.

1. All intelligent analog devices shall be tested and logged for correct address and sensitivity using test equipment specifically designed for that purpose. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the system address, initials of the installing technician and date.
2. Wiring runs shall be tested for continuity, short circuit and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
 - a. A systematic record shall be maintained of 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 acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector, shall be corrected.
 - c. Test reports shall be delivered to the acceptance inspector as completed.
3. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
 - a. Ladders and scaffolds as required to access all installed equipment.
 - b. Multimeter for reading voltage, current and resistance.
 - c. Intelligent device programmer/tester.
 - d. Laptop computer with programming software for any required program revisions.
 - e. Two way radios, flashlights, smoke generation devices and supplies.
 - f. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.

- g. Decibel meter.
 - 4. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.
 - 5. System wiring: fire alarm circuits shall be tested for continuity, grounds, and short circuits.
- B. Acceptance testing.
- 1. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the Acceptance Inspector in accordance with NFPA 72, and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.
 - 2. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.
 - 3. A complete listing of all device labels for alpha numeric annunciator displays and logging printers shall be prepared by the installing contractor prior to the ATP.
 - 4. The acceptance inspector shall use the system record drawings in combination with the documents specified under Paragraph 3.1 during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
 - a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
 - 1) Open, shorted and grounded intelligent analog signaling circuit.
 - 2) Open, shorted and grounded network signaling circuit.
 - 3) Open, shorted and grounded conventional zone circuits.
 - 4) Open, shorted and grounded speaker, telephone circuits.
 - 5) Intelligent device removal.
 - 6) Primary power to battery disconnected.
 - 7) Incorrect device at address.
 - b. System evacuation alarm indicating appliances shall be demonstrated as follows:
 - 1) All alarm notification appliances actuate as programmed.
 - 2) Audibility and visibility at required levels.

- c. System indications shall be demonstrated as follows:
 - 1) Correct message display for each alarm input at the control panel, each remote alphanumeric display and each CRT terminal.
 - 2) Correct annunciator light for each alarm input at each annunciator and color graphic terminal as shown on the drawings.
 - d. Secondary power capabilities shall be demonstrated as follows:
 - 1) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
 - 2) System primary power shall be restored for forty-eight hours and system charging current shall be normal trickle charge for a fully charged battery bank.
 - 3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.
5. In the event of system failure to perform as specified and programmed during ATP procedure, at the discretion of the acceptance inspector, the test shall be terminated.
- a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
 - b. In the event that software changes are required during the ATP, a utility program shall be furnished by the system manufacturer to compare the edited program with the original. This utility shall yield a printed list of changes and all system functions, inputs and outputs effected by the changes. The items listed by this program shall be the minimum acceptable to be re-tested before calling for resumption of the ATP.
 - c. The acceptance inspector may elect to require the complete ATP to be performed again if, in their opinion, modifications to the system hardware or software warrant complete re-testing.

3.08 DOCUMENTATION

- A. System documentation shall be furnished to the owner and shall include but not limited to the following:
 - 1. System record drawings and wiring details including one set of reproducible masters and drawings on CD ROM in a DXF format suitable for use in a CAD drafting program. System operation, installation and maintenance manuals.
 - 2. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
 - 3. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.

4. System program showing system functions, controls and labeling of equipment and devices. Also provide a copy of the system files on CD ROM in PDF format.

3.09 TEST EQUIPMENT

- A. Refer to Division 01 for General commissioning requirements.
- B. The Contractor shall furnish all test equipment as required to program devices and test the system, specifically an intelligent device tester and programmer.

3.10 INTERFACE TERMINAL BOX

- A. The fire alarm system contractor shall install the interface terminal box at the main fire alarm control panel in a readily accessible location no more than 8'-0" A.F.F.
- B. The fire alarm contractor shall wire from the fire alarm system to the interface terminal box.
- C. The security contractor shall wire from the security system to the interface terminal box.

3.11 INTERFACE TERMINAL BOX

- A. The fire alarm contractor shall provide all conduit, power and wiring required for the installation of the terminal box, manual unlock switch and interfacing to the fire alarm system. All wiring installations shall meet NFPA 70 and be UL listed for the fire alarm applications.

3.12 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, the fire alarm system subcontractor or manufacturer shall provide at no additional charge the inspection, parts, maintenance, testing and repair to maintain the system in full compliance with the requirements of NFPA 72.
- C. A NOTIFIER® trained technician in the employ of the installing fire alarm contractor shall furnish training to the Owner's employees on operation of the fire alarm system.
 1. Training in the receipt, handling and acknowledgement of alarms.
 2. Training in the system operation including manual control of output functions from the system control panel.
 3. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
 4. The total training requirements shall be a minimum of 6 hours but shall be sufficient to cover all items specified.

END OF SECTION